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Telecom and Signal Relays

AXICOM

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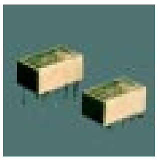
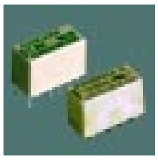
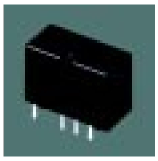
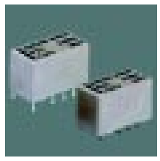
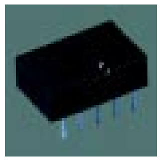
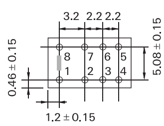
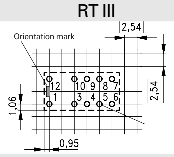
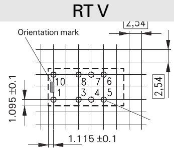
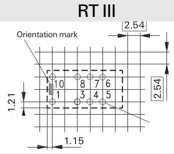
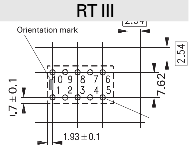
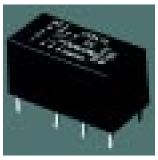
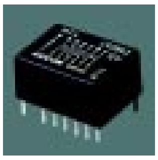
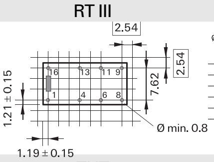
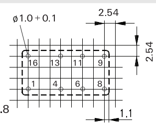
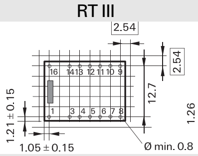
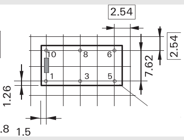
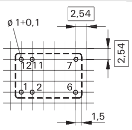
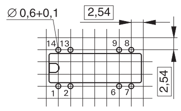
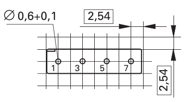
Types		IM	P2	FX2	FT2 / FU2	FP2
						
Dimensions [mm]		10 x 6 x 5,65	14,5 x 7,2 x 10,4 (9,9)	15 x 7,3 x 10,7	15 x 7,5 x 9,6 (10,0)	14 x 9 x 5
Features		4th generation Telecom Relay Slim line / low profile	3rd generation Telecom Relay, Slim line, Switching current 5A	3rd generation Telecom Relay, Slim line, Standard and sensitive coil	3rd generation Telecom Relay, Slim line, Standard and sensitive coil	3rd generation Telecom Relay, Low profile, Standard and sensitive coil
Characteristic		Polarized	Polarized	Polarized	Non-Polarized	Polarized
Contact arrangement		DPDT / 2 Form C, bifurcated contacts	DPDT / 2 Form C, bifurcated contacts	DPDT / 2 Form C, bifurcated contacts	DPDT / 2 Form C, bifurcated contacts	DPDT / 2 Form C, bifurcated contacts
Coil voltages [V]		1,5 - 24	3-24	3-48	3-48	3-48
Coil power [mW]	non latching latching, 1 coil latching, 2 coils	140 - 200 100 - 200 -	140 70 140	Standard: 140 - 300 Sensitive: 80 - 260 100 - 150 -	Standard: 300 Sensitive: 200 - 240 - -	140 (24V = 200, 48V=300) 80 (24V = 140, 48V =260) 100 (24V = 150) 200
Ambient temperature [°C]		-40 ... +85	-40 ... +85	-55 ... +85	-55 ... +85	-55 ... +85
Switching voltage [V]	DC AC	220 250	220 250	220 250	125 250	125 250
Switching current [A]		2	5	2	1.25	2
Switching power [W / VA]		60 / 62.5	60 / 62.5	60 / 62,5	30 / 62.5	30 / 62.5
Contact resistance, Initial [mΩ]		< 50	< 50	< 70	< 70	< 50
Thermoelectric potential [µV]		< 10	< 10	< 10	< 10	< 10
Breakdown voltage [Vrms]		1800 1000 1000	1500 1000 1000	1800 1800 1800	1500 1500 1500	1000 1000 750
Breakdown voltage pulse [kV]	Coil-contact Opened contacts Adjacent contacts	2500 (2/10 µs) 1500 (2/10 µs) 1500 (2/10 µs)	2500 (2/10 µs) 2500 (2/10 µs) 2000 (2/10 µs)	3500 (2/10 µs) 2500 (2/10 µs) 2000 (2/10 µs)	2500 (2/10 µs) 1500 (2/10 µs) 1500 (2/10 µs)	1500 (10/160 µs) 1500 (10/160 µs) 1500 (10/160 µs)
RF characteristics at 900 MHz		-18.8 -0.33 1.49	-20.7 -0.27 1.4	-15.1 -0.6 1.45	-13.7 -0.5 1.27	-22.3 -0.25 1.07
Capacitance between opened contacts [pF]		max. 1	max. 1	max. 2	max. 1	max. 1
Sealing		IP 67 RT V	IP 67 RT III	IP 67 RT V	IP 67 RT III	IP 67 RT III
Mounting hole layout						
Termination		THT, SMT	THT, SMT	THT	THT, SMT	THT
Certifications		UL, CSA, CECC, IEC60950, UL 1950	UL, CSA, IEC 60950	UL, CSA, CECC, IEC 60950, UL 1950	UL, CSA, CECC, IEC 60950, UL 1950	UL, CSA, CECC
Options		High Dielectric Version: 2500 V pulse between opened contacts Lead-free Version	Temperature range up to 105°C,1500 Vrms between opened contacts	High mechanical shock version: 300 g	High dielectric version: 5000 Volt pulse between coil and contacts 2500 Volt pulse between all contacts	High mechanical shock version: 300 g
Page		42	49	57	63	70

AXICOM

MT2	D2n	MT4	P1	W11	Reed DIP	Reed SIL	Cradle
							
20,2 x 10 x 11	20 x 10 x 11,5	20 x 14,8 x 11		15,6 x 10,6 x 11,5	19,3 x 7 x 5,7 ...7,5	19,8 x 5,1 x 7,8	24 ... 35 x 19 x 30
2nd generation Telecom Relay, 5 coil sensitivities	2nd generation Telecom Relay, 4 coil sensitivities	2nd generation Telecom Relay, 4 contact sets	Very high sensitive relay, Low profile High vibration & shock resistance	Multi purpose relay switching current up to 3 A	Direct driving with TTL signals Ultrasonic cleanable High switching speed	Direct driving with TTL signals Ultrasonic cleanable High switching speed	Very high reliability Great variety of coils and contact sets Accessories for socket mounting
Non-Polarized	Non-Polarized	Non-Polarized		Non-Polarized	Non-Polarized	Non-Polarized	Non-Polarized/Polarized
DPDT / 2 Form C, bifurcated contacts	DPDT / 2 Form C, single contacts	4PDT / 4 Form C, bifurcated contacts	SPDT / 1 Form C, bifurcated contacts	SPDT / 1 Form C, single contacts	SPST-no / 1 Form A, DPST-no / 2 Form A, SPDT / 1 Form C, Reed contacts	SPST-no / 1 Form A, Reed contacts	various
4,5 - 48	3-48	4,5 - 48		1,5 - 24	5-24	5-24	5 ... 220 DC/6 ... 230 AC
150 - 550 - -	150 - 700 - -	300 - -	65 - 130 30 - 130 70 - 200	200 - 450 - -	50-300 - -	50-300 - -	650 ... 2000 Cradle W: 3,5 ... 4, VA 1450 ... 1650 1450 ... 1650
-55 ... +85	-25 ... +60 to 85	-55 ... +85		-40 ... +70 to 85	-20 ... +70	-20 ... +70	-40 ... +70
220 250	220 250	220 250	125 150	60 125	175 ... 200 175 ... 200	180 ... 200 180 ... 200	36 ... 250 30 ... 250
2	3	1.25		1-3	0,25 ...0,5	0.5	0,2 ... 5
30 / 62.5	60 / 125	30 / 62.5	30 / 60	AgNi: 72 / 360 AgPd (Au): 30 / 60	3 ... 10	10	5 ... 140 (5 ... 500)
< 70	< 100	< 70		< 100	< 150	< 150	on request
< 10	< 10	< 10	< 100	< 10	< 0,01	< 0,01	on request
1000 750 750	1000 750 750	1800 750 750		1000 750 -	1000 140 ... 175 -	1000 150 ... 175 -	500 ... 2000 500 ... 1000 on request
1500 (10/160 µs) 1500 (10/160 µs) 1500 (10/160 µs)	1500 (10/160 µs) 1500 (10/160 µs) 1500 (10/160 µs)	2500 (2/10 µs) 1500 (10/160 µs) 1500 (10/160 µs)	2500 (2/10 µs) - -	- - -	- - -	- - -	- - -
-14.2 -0.97 1.31	-20.7 -0.27 1.4	-17.2 -0.91 1.31		- - -	- - -	- - -	- - -
max. 2	max. 1	max. 2	max. 5	max. 2	max. 1	max. 2	on request
IP 67 RT III	IP 67 RT III	IP 67 RT III		IP 67 RT III	IP 67 RT III	IP 67 RT III	IP 30 or hermetically sealed, RT I or RT V
							see data sheet
THT	THT	THT		THT	THT	THT	THT or plug in
UL, CSA, CECC	UL, CSA, BT47	UL, CSA, CECC	UL, CSA				
					Clamping Diode, Electrostatic shield	Clamping Diode	
76	82	88	94	102	108	111	114

AXICOM – Innovations for Telecommunication and Signal Relays

I. Introduction

A. Decades of experience

Tyco Electronics acquired AXICOM in October 2000 and SIEMENS EC and its relay activities exactly one year earlier. AXICOM is now the new brand within Tyco Electronics for the Telecom and Signal Relay business created out of these two acquisitions. This merger combines the knowledge and experience achieved over decades. Both AXICOM, which was formerly a part of Alcatel and ITT, and Siemens EC have been in the relay business for more than 50 years. And for about the same time, there have been discussions around whether relays in general would be replaced by "more modern" solutions, for example, semiconductors. However, relay manufactures have always designed smart and cost effective relays which are still the first choice for most applications.

B. Features of Telecom and Signal Relays

The major advantages of Telecom Relays are
- robust and reliable even in harsh environments
- large switching range from µV and µA to A and 250 V
- low contact resistance in the closed condition (mΩ) and high insulation resistance in the open condition (MΩ)
- high insulation between coil and contacts (up to 5000 V) and between open contacts (up to 2500 V)
- good RF characteristics
- easy to use
- cost effective

Table 1 gives an overview:

	Telecom and Signal Relays	Transistor	Solid State Relays	Optocoupler
Full mech. separation	yes	no	only dr./load	only dr./load
Overload capability	high	low	low	low
Dielectrics	high	low	high	high
Contact resistance	low	medium	high	high
On-resistance stability (dep. on input / temp.)	yes	no	no	no
Bidirectional loads	yes	no	yes	no
Bouncing	yes	no	no	no
Leakage current	no	yes	yes	yes
Driving power	high	low	medium	medium
Switching time	high	low	high	low
No. of switching cycles	medium	high	high	high
Package	no standard	standard	standard	standard
Price	medium	low	high	medium

Tab. 1 Characteristics of relays and competitive technologies

Despite all the technical aspects, the Telecom and Signal Relay business is driven by:
- decreasing volume and required board space on the PCB
- increasing the dielectric, voltage and current surge performance
- improving the processability
- increasing the quality level and reliability
- reduced cost

Major innovations during our decades of experience have revolutionized electromechanically actuated Telecom Relays. In spite of a noticeable reduction in their physical size, all their significant characteristics have been improved by every new generation.

Integrated Development
Today, Telecom Relays are complex electromechanical systems consisting of a highly efficient electromagnetical actuator and a contact set. In order to achieve a product that is:
- cost effective
- easy to manufacture
- high performance
- high quality and
- highly reliable,

the complete chain from design to manufacturing has to be optimized. An integrated approach must be perfectly established that includes all the steps of a product life cycle:
- design of the product
- design and manufacture of tools
- engineering of production equipment
- manufacturing and logistics
- quality assurance
- feedback between all activities

To live and to control this process is our strength and the base of our success.

C . Technology

Major innovations in the relay technology developed in the last few years are:
- ENG (gas-tight plastic sealed relays filled with insulting inert gases)
- Flat coil technology which enables the design of significantly smaller relays
- Application of high performance low out-gassing plastics, magnetic wires and epoxy resins
- Introduction of high performance contact materials
- Use of environmental friendly materials

At the same time, a highly efficient manufacturing technology was established, enabling
- overmolded coils and ENG technology
- performance and precision of punching and molding processes
- multiple part overmolding

- fully automatic production lines
- extremely short manufacturing cycle times
- in-process measurement technology
- quality assurance methods

The optimal combination of an advanced relay technology and a highly automated manufacturing process makes AXICOM into one of the leading companies in terms of quality and costs for electromechanical relays.
The quality level achieved and the AOQL (average outgoing quality level) of less than 25 ppm and a reliability of AXICOM relays with MTBF (mean time between failures) of more than 30,000 years is the clear evidence for the outstanding technology as well as the brilliant skill and experience of our people.

II. Relay Classification

The classification of relays can be done on three levels:

- application fields
- actuator design
- relay generations.

	Telecom Relay	Signal Relay
Contact configuration	mostly 2 c/o	various
Contact resistance (during total life time)	< 1 Ω, stable	< 100 mΩ, very stable
Load range	µV ... 250 V µA ... 2 A < 60 W	µV .... 10 V µA .... mA < 10 W
Endurance / lifetime	> 1 million ops. > 25 years	< 100 mill. ops. > 10 years
Safety requirements	optional, IEC/EN 60950 UL 1950	no
Surge (e.g. according to Telcordia or FCC)	> 2500 V < 500 A	no requirements

Tab. 2: Major differences between Telecom and Signal Relays

A. Application fields

According to their application fields, relays are divided into Automotive Relays, General Purpose or Power Relays, Telecom and Signal Relays and High Frequency Relays. The most important difference between these application fields is the contact loads.

- **Automotive Relays** usually work in 6 V, 12 V or 24 V and in the future also in 42 V car networks. Switching currents can rise up to more than 150 A.

- **General Purpose or Power Relays** are mainly used for applications in 120 Vac or 230 Vac power networks and for switching currents up to 30 A. For security reasons, dielectric strength between coil and contact side as well as internal air and creepage distances are essential design features. Independent from the load, it is common for automotive and general purpose / power relays to further distinguish between PCB and plug-in relays. While PCB relays are soldered directly on a board, plug-in relays are inserted into a socket.

- **Telecom and Signal Relays** are used in a range from dry circuit up to analog telecom signals. This means voltages from µV to 250 Vrms and currents from µA to 2 A have to be handled. Furthermore, in this relay class dielectric strength and clearance and creepage distances have to be considered but on a lower level compared to General Purpose or Power Relays. Sometimes Telecom and Signal Relays are just called signal or PCB relays (Tab. 2)..

- **High Frequency Relays** are designed for applications were signals of several hundred MHz up to several GHz have to be switched.

B. Actuator design

Another distinction is made according to the design of the relay actuator (Fig. 1).

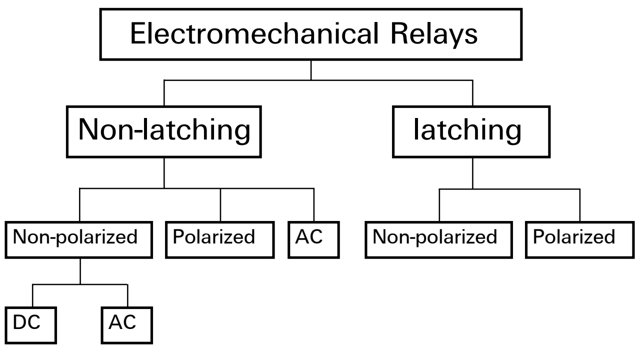


Fig. 1 Relay classification according to actuator type

- **Polarized / non-polarized relays**
  A polarized relay needs a driving current of defined direction to switch. A non-polarized relay can be switched with currents in either direction. A polarized actuator usually includes a permanent magnet that enables it to realize more sensitive systems.

- **Latching / non-latching relays (also called bistable / monostable relays)**
  A non-latching relay always returns to a defined contact position when power is removed from the actuator. A non-latching relay can either be polarized or non-polarized.
  A latching relay always remains in its current contact position when power is removed from the actuator. A latching relay is always polarized.
- **Relays with AC / DC actuator** Most relays described under application fields are relays with DC actuators. However, some Signal and General Purpose Relays use AC actuators that can be directly driven by a power network. AC actuators are always non-polarized.

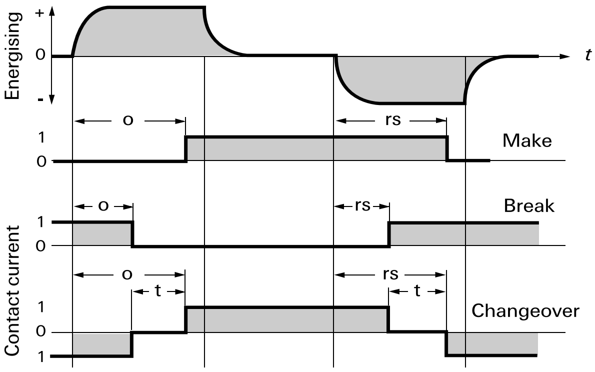


Fig. 2 Relay timing

C Relay Generations

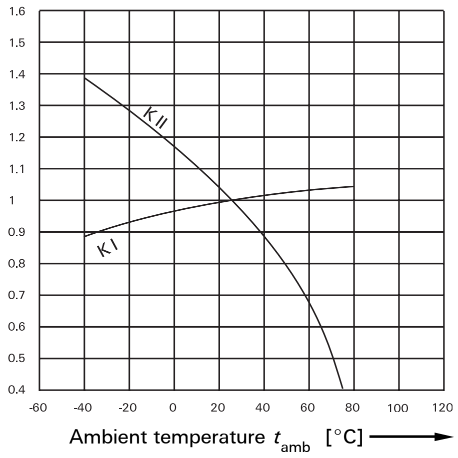
In the past, especially for Telecom Relays the definition of relay generations was established from both, relay manufacturers and customers for office switching equipment. Today, the most current is the 4th generation of Telecom Relays (IM series). This is the smallest available electromechanical relay type.
The 3rd generation relay (P2, FX2, FP2, FT2, FU2 series), designed in the early to middle nineties is currently the high runner, whereas the 4th generation is expected to take over this position in the near future.
The 2nd generation relay (MT2 and MT4) was designed in the middle of the eighties. It is also remarkable that from the 2nd generation of Telecom Relays a distinct standardization of dimensions and pinning was realized and this is still the case with today's 4th generation.
Examples of the 1st generation are Tyco Electronics' still existing Cradle Relays (formerly Siemens EC). These relays were designed more than 30 years ago.

III. Functional parameters

From a functional point of view, all types of relays have to fulfill requirements regarding timing and operating voltages, including temperature influence.
Timing basically is defined by operate, release and bouncing times. Fig. 2 shows a typical relay timing diagram:

The operate time of an electromagnetic relay is defined as the time from power is applied to the coil to the first contact of a normally closed contact opens or the first contact of a normally opened contact closes. During the operate time energy in the magnetic system is built up to move the contact set. The release time of an electromagnetic relay is defined as the time between when power is removed from the magnetic system until the first contact of a normally opened contact opens or the first contact of a normally closed contact closes. During the release time, the energy in the magnetic system decreases until the contact set moves back from the operate position. The release time is influenced by protective devices like diodes, capacitors and resistors in parallel to the relay coil. These devices retard the de-energization of the coil, prolonging the release time.
Operate and release times vary with the voltage applied to the actuator. (See relay terms.)
Contact bouncing is originated by the dynamic energy of the movable contact when it hits the fixed contact and varies with the voltage applied to the actuator as well. The operate and release times does not include bouncing.
Operating voltages of electromagnetic actuators depend on ambient temperature as, on one hand, the copper of the coil windings and all magnet materials have a temperature coefficient and, on the other, the maximum operating temperature of a relay is limited. A typical diagram is shown in Fig. 3 using the so-called K-factors (see also relay terms):

It can be observed that the maximum coil voltage decreases with higher ambient temperatures as the maximum coil temperature should not be exceeded over the whole temperature range. Furthermore, in this example, the minimum or operate voltage shows a non-linear temperature range, which indicates that this relay contains a magnet. The temperature coefficient of only the coil copper would be linear. The same behavior as that for the minimum operating voltage has to be applied for the release voltage. As a consequence, the release voltage of a non-latching relay decreases with the temperature as well. The specified release values in our data sheets guarantee proper function down to the minimum temperature.



U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current

U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\ tamb} = K_I \cdot U_{I\ 23°C}$

and

$U_{II\ tamb} = K_{II} \cdot U_{II\ 23°C}$

t_{amb} = Ambient temperature

$U_{I\ tamb}$ = Minimum voltage at ambient temperature, t_{amb}

$U_{II\ tamb}$ = Maximum voltage at ambient temperature, t_{amb}

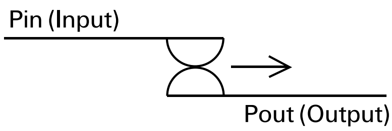
k_I, k_{II} = Factors (dependent on temperature), see diagram

Fig. 3: Temperature dependence of operate and release voltages and maximum allowed temperature

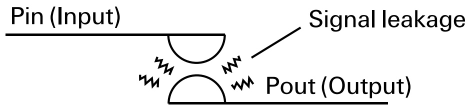
IV. RF characteristics

The RF characterization of electromechanical relays can basically be defined by four RF parameters plus the system impedance. These parameters describe how RF signals are transferred or reflected on their way through the relay (irradiation usually can be ignored). It is obvious that in RF applications, the main focus for these parameters is on the contact set as relays do not switch with high speed but switch RF signals over the contacts.

- Transmission characteristic (S_{21}) is defined by insertion and isolation loss

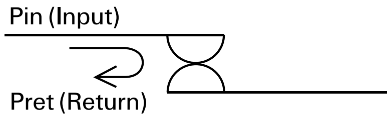


$$\textit{Insertion loss [db]} = -10 \log \frac{P_{out} \textit{(output power)}}{P_{in} \textit{(input power)}}$$



$$\textit{Isolation [db]} = -10 \log \frac{P_{out} \textit{(output power)}}{P_{in} \textit{(input power)}}$$

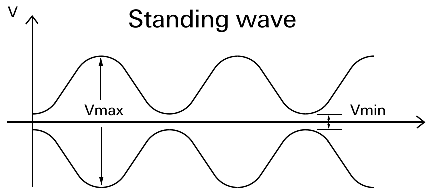
Fig. 4: Isolation loss



$$\textit{Return loss [db]} = -10 \log \frac{P_{out} \textit{(return power)}}{P_{in} \textit{(input power)}}$$

Fig. 5: Return loss

- Reflection characteristic (S_{11}) is defined by return loss and VSWR (voltage standing wave ratio)



$$VSWR = \frac{1 + 10^{-\frac{\text{Re turn loss}}{20}}}{1 - 10^{-\frac{\text{Re turn loss}}{20}}}$$

Fig. 6: Voltage standing wave ratio (V.S.W.R)

The impedance match of component and system is important as a mismatch generates signal reflection and losses. Common RF applications are either 50 Ω or 75 Ω systems, which means that the relay should match with one of these two values for it's own impedance.

For a variety of our standard relays, these RF parameters are given in the appropriate data sheets.

For the internal design of RF relays very similar principles as for PCB designs or cables are used as shown in Fig. 7.

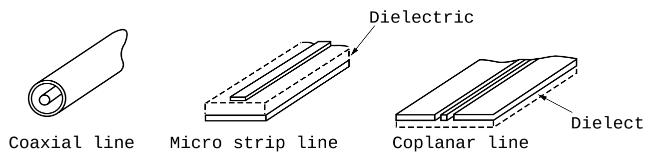


Fig. 7: Design examples for RF relays

All design principles consist of a signal layer, ground layer and a dielectric layer where the electric field is concentrated between signal and ground layer. Micro-strip and coplanar design are also widely used for RF PCB designs, whereas coaxial design is used for cables. RF component manufacturers usually define layout recommendations together with the component design due to the fact that the transition from the PCB to the relay has a significant influence on the component's RF performance.

V. Relay driving

There are different ways of driving a relay depending on whether the relay is a latching or non-latching type. As described in the paragraph classification, a non-latching relay returns to a defined release position when power is removed from the actuator. However, a latching relay needs a voltage pulse with defined polarity for both setting and resetting. For one coil latching relays, the voltage pulse for set and reset has to be of different polarity, for two coil latching relays, these pulses can be of same polarity. On two coil latching relays both coils can be used for setting or resetting the relay.

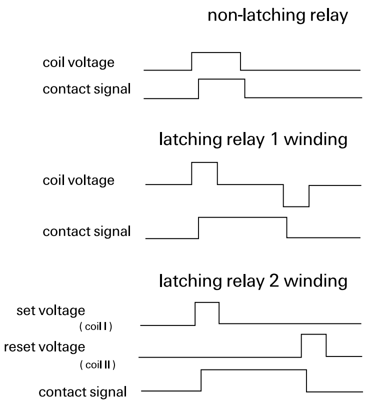


Fig. 8: Relay driving

It is possible to drive a latching relay as a non-latching type using the so-called C-circuit. Here a capacitor is connected to the coil in series. With the correct choice of the capacitor, depending on the coil values, the current pulse while charging the capacitor is enough to switch the relay to the set position. The same is valid for discharging the capacitor and resetting the relay. For detailed information, please contact our relay specialists.

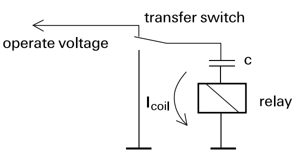


Fig. 9: C-Circuit

Generally, when power of a relay coil is removed, due to the self-induction of the relay coil, a voltage peak occurs. This voltage peak might be very short but exceeds the nominal coil voltage by a factor up to 10. As many electronic components, especially semiconductors, are quite sensitive to voltage peaks, it is very common to put resistors or diodes in parallel to the relay coil which reduces the voltage peak to a defined level. By using these coil suppression components release time is increased. For higher contact loads this might lead to a reduced life-time due to longer arcs across contacts. For detailed information, please contact our relay specialists.

VI. Contact Performance

A. Contact physics

The contact is the key functional element of the relay. The contact system has to provide:

- low and stable contact resistance
- switch a wide load range from dry circuits up to a maximum load of 60 W/62.5 VA
- high insulation
  - between open contacts
  - between control and load circuit

1. Contact resistance

Whenever two conductors are put together in order to conduct a current, an electrical contact is formed. By definition an electric contact means a junction between two conductors called contacts.

Due to the surface roughness and unevenness of the contacts only part of the nominally flat contacts touch each other. The consequence is that the resistance will be higher than that of a straight conductor because:

- the mechanical touching area is always smaller than the obvious touching area
- the electrical conductive area is smaller than the mechanical surface due to contamination of the contact surface
- the electrical conducting area is also covered with non-metallic layers

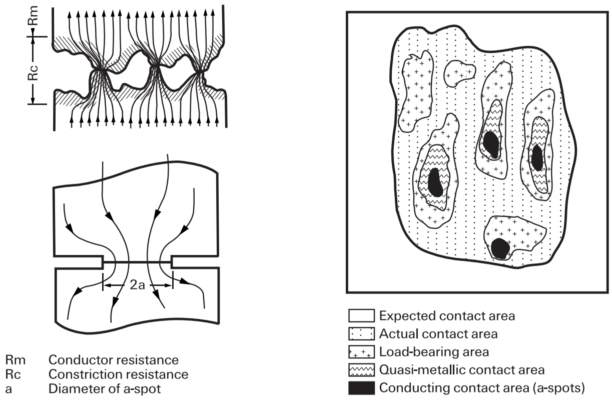


Fig. 10: Constriction resistance

Fig. 10 shows that the constriction resistance is not caused by the interface between the two contact members. The resistance is caused by the elongation of the distance. It is defined by the conductivity of the contact materials and the contact force applied, which defines the number and the size of the contact spots.

$$R_c = \rho/2a$$

ρ = *conductivity of the contact material*
2a = diameter of the contact spot

Bearing in mind the plastic deformation of the metallic conduction spots, the constriction resistance can be computed thus:

$$R_c = \rho/2a = \rho\,(\pi/4)^{1/2}\,H/F_c$$

R_c = *constriction resistance*
F_c = *contact force*
ρ = *conductivity of the contact material*
H = hardness of the contact material

The constriction resistance is caused by the increased distance the current has to flow. For example, for Ag as contact material and a contact force of 10 cN, an effective contact diameter of 10 µm and a contact resistance of 1 mΩ can be expected.

Remark: The pin to pin resistance or contact circuit resistance consists of the resistance of the conductive tracks and the contact resistance. While the first part is constant, the contact resistance might change during the life of the relay.

2. Contact temperature - Wiedeman-Franz Law

The dimension of the contact area is so small that the temperature in the contact cannot be measured, but it can be easily determined by measuring the contact voltage:

$$U_c = R_c\, I$$

As both the electrical conductivity and the thermal conductivity in metals are caused by the free electrons in the metal, the electrical and thermal conductivity are proportional

$$\rho/\rho_{th} = A\,T$$

$$A = 2.4 \times 10^{-8}\,(V/K)^2$$

A = Wiedemann-Franz or Lorenz Factor
T = temperature

The correlation between the contact voltage and the temperature increase in the contact constriction area can be determined by:

$$\Delta T_c = T_c - T_a = U_c^{\,2}/(8A\,T_a)\ [mV]$$

T_c = *temperature of the constriction area*
T_a = *ambient temperature of the contact*
U_c = *contact voltage*
A = Wiedemann-Franz or Lorenz factor

With this equation the temperature of the contact constriction area can be determined. Therefore, a direct correlation between the softening, melting and boiling voltages and the related softening, melting, boiling temperatures is given. For silver the values are 90 mV, 370 mV and 750 mV.

3. Contaminated contact surfaces

Contamination of contacts has to be prevented by proper selection of the contact material, insulation material and manufacturing processes.

a) Single atomic layers

All metallic surfaces, including precious metals like gold or silver, are covered with at least a single layer of oxygen when they are stored in air. These O_2 molecules are attached to the contact surface. They can only be removed by annealing in a vacuum for several hours.
The oxygen layers, which are about 0.5 nm thick, disturb the current flow and increase the contact resistance. In practice, the electrons are able to pass this barrier. The effect that enables the electrons to pass through a thin insulating barrier is called the "tunnel effect". In reality, the tunnel resistance is not significant, but the fact that the metallic surfaces are covered prevents the contacts from cold welding.

b) Corrosion layers

In air oxides, sulfides and other layers are formed on all metallic surfaces and cannot be passed through by tunneling. On most metals, the growth of the layers slows down because diffusion through the coating layer is no longer possible. The formation of corrosion layers is stopped or at least it proceeds much more slowly. The higher the thickness of the layer, the slower the corrosion layer increases. The speed of the chemical reaction process is strongly (exponentially) dependent on the temperature. All corrosion layers are insulating or are semiconductors. This is definitely insufficient for a technical contact. In order to provide a proper technical contact, this corrosion layer must be destroyed.
There are two possible ways of destroying these layers:

- electrically
- mechanically

Electrically: The breakdown voltage of corrosion layers is in the range of 10^8 to 10^9 V/m. The breakdown voltage which is called "fritting voltage" can reach values of more than 100 V. The breakdown occurs in such a way that when the fritting (electrical breakdown) occurs, a thin metallic channel is formed. When this happens, the contact voltage is reduced to values between 0.3 and 0.5 V (cessation voltage). This voltage is just below the melting voltage or melting temperature of the contact material. The final resistance of a fritted contact is not sufficient in most cases (100 mV contact voltage results in a resistance of 10 Ω at 10 mA).

Mechanical: There are two ways to destroy the corrosion layers on a contact.

- high enough contact force
- relative movement or mechanical impact during contact closing

Either the contact force is high enough to destroy the insulating layers or a relative movement is also applied in order to destroy the corrosion layers.

c) Polymeric coatings

When contacts are operated under dry load conditions, especially on contacts made from Pd and Pt and their alloys, absorbed organic molecules are polymerized. The organic polarized layers have an insulating effect. When the contacts perform a relative movement, these organic layers are removed and deposited beside the contacts. The deposited products are called "brown powder".

d) Carbon layers

When contacts are operating in a closed environment (sealed relay) and the switch is made of organic materials like plastics, resins and organic insulation materials, outgassing hydrocarbons can cause carbon on the contacts.

This effect can be observed in a typical load level between 5 and 2 V and currents between a few mA and 100 mA. The out-gassing hydrocarbons are absorbed on the contact surface. The low energy arc caused in this load range cracks the hydrocarbons. As the energy of the arc is not sufficient to burn the carbon, it simply remains in the contact area. Typical contact resistance values for carbon can be measured which are in the range of 1 to 2 Ohms.

e) SiO_2 - coatings

The insulating SiO_2 – coatings are formed from silicone, when it is present in the contact area and arcing occurs (Fig.11). The organic silicone molecules are oxidized in the arc and form an insulating layer. Silicone has extreme creeping characteristics and is able to cross long distances (>20 meters).

Silicones come from grease, hand-cream, etc. NEVER use creams, grease, oils, etc., containing silicones when contacts are present. Creeping of silicones even through plastic housings has been observed in the past.

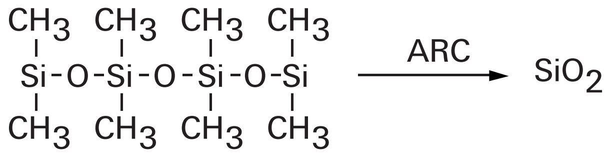


Fig. 11: Formation of SiO_2 by the arc

f) Particles

Particles are the biggest enemies of an electrical contact. Particularly in miniaturized electromechanical systems with low contact forces, small particles can prevent the contacts from making contact.

Typical sources might be dust when open relays are used or particles coming from punched metal parts, grids from molded parts and particles coming from assembly operations like handling and laser welding.

4. Arcing contacts

It makes a significant difference whether a contact has to switch AC or DC currents and voltages. Switching AC loads is usually much less critical because during every cycle the current as well as the voltage have zero crossing. This is not the case when a DC circuit has to be switched.

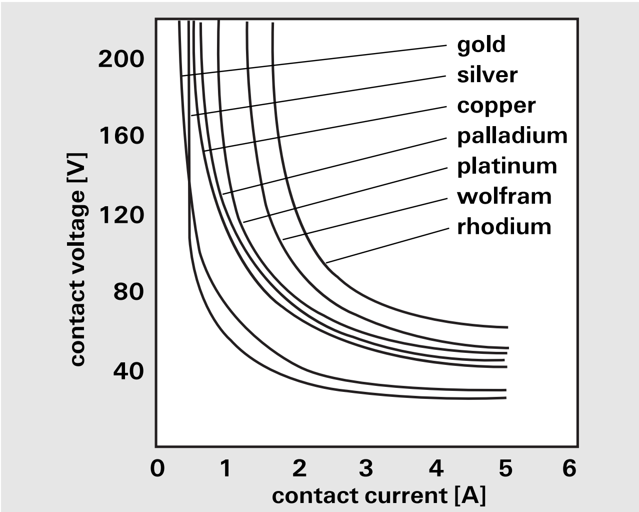


Fig. 12: Minimum arc voltage for different contact materials

a) Switching DC circuits

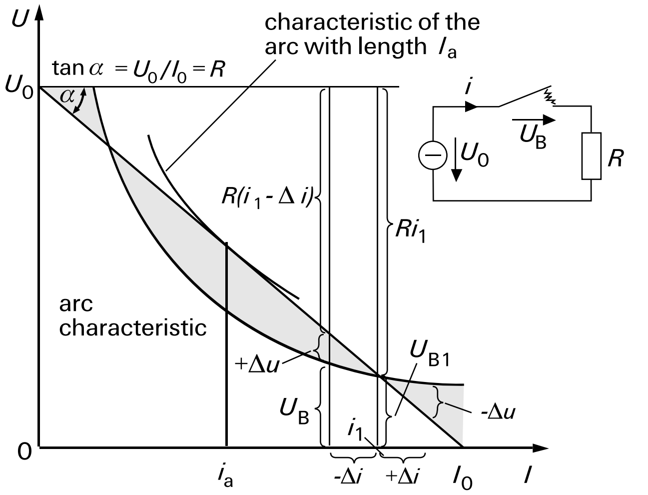


Fig. 13: Determination of arc current and arc voltage applying and characteristic.

A DC circuit is interrupted (the arc is extinguished) as soon the required arc voltage is no longer available. This is the case when the arc voltage U_B is bigger than the open circuit voltage when U_o, reduced by the voltage drop on the resistor. Applying the arc characteristic makes it easy to calculate the arc voltage and the arc current. At the same time, the length of the required contact gap for interrupting the circuit can be determined. Examples are shown in Fig.13.

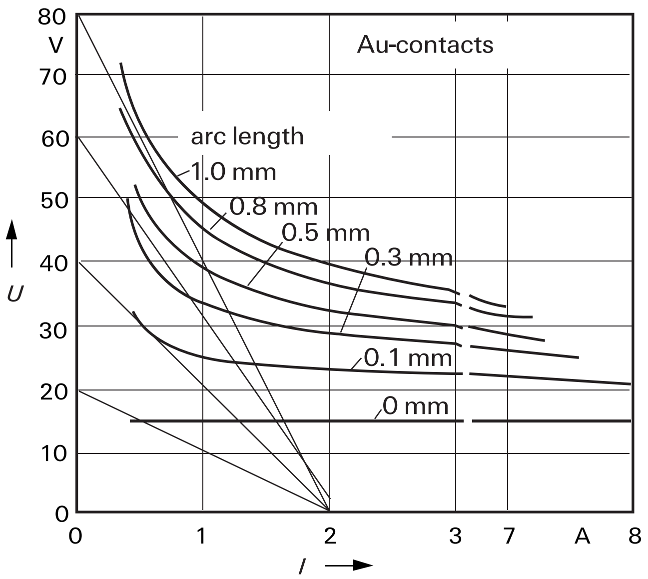


Fig. 14: Voltage – current characteristics of arc burning on gold contacts in air.

Capacitive loads
When capacitive loads have to be switched, the current must be limited by a resistor. The maximum current should not exceed 15 A, otherwise the inrush current might cause contact welding.

Inductive loads
When inductive loads are switched off, the energy stored in the inductance results in the generation of an arc or an increase of the arc duration depending on the circuitry.

b) Switching AC circuits
When the current goes through zero, no energy is supplied to the arc. The arc should therefore extinguish by itself. As the whole system has a certain heat capacity, the arc can re-ignite, especially when the contact opens slowly and there is not sufficient dielectric strength available to prevent a re-ignition of the arc.

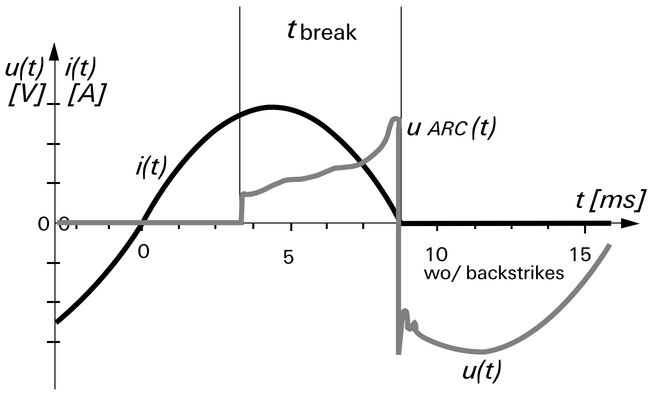


Fig. 15: Interruption of an AC circuit.

5. Material transfer and contact erosion

In DC circuits, material transfer and contact erosion are among the main factors reducing the lifetime and performance of relays.

Material transfer generates a spike on one contact and a hole on the other (Fig. 16). Depending on the load applied and the contact material, the height of the spike can easily reach 20 to 30 % of the contact gap. Minimizing the material transfer helps to keep the dielectric characteristic constant during the entire life of the relay and therefore enables designs with smaller contact gaps.

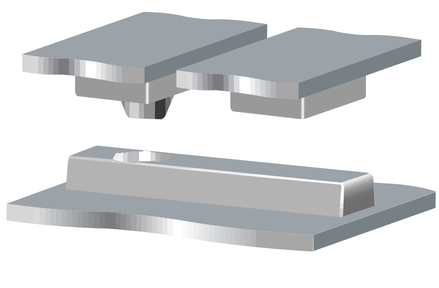


Fig. 16: Material transfer

a) Steady state arcs

For steady arcs, a minimum arc voltage and current are necessary. Both the minimum voltage and the minimum current depend on the electrode material and the surrounding gas, e.g. for silver, in air U_{min} = 12 V, I_{min} = 0.4 A (Fig. 12).

b) Opening contacts

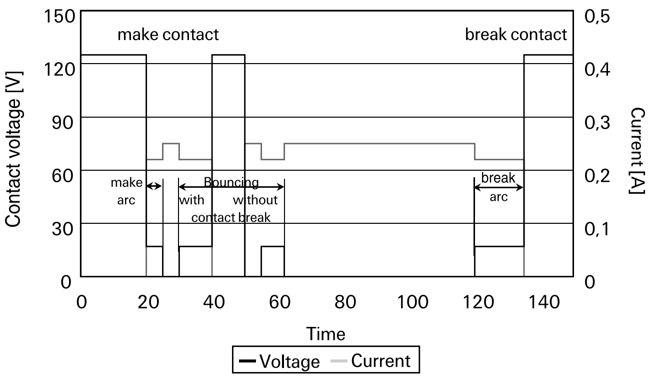


Fig. 17: Voltage and current during contact make and break.

Although in many telecom circuits neither the minimum arc voltage nor the minimum arc current is reached, material transfer can be observed.

This can be explained as follows. When contacts are separated, the force decreases, the contact resistance and therefore the contact voltage increases (which is a function of the temperature in the constriction area) until the melting temperature of the contact material is reached. A molten bridge is formed between the contact pieces. The contact voltage during this time is constant at the melting voltage of the contact material. As the contact distance increases, the temperature inside the molten bridge likewise increases. At a certain distance, the bridge disintegrates. This metallic vapor creates the ideal conditions for an arc discharge.

A very strong electric field arises across the hot metal vapor causing temperature field emission of electrons from the cathode. These electrons excite and progressively ionize the metal atoms. The ions produce a high-density space charge and increase in electrical field strength in front of the cathode, yielding a cathodic emission density sufficient to sustain an arc. This arc is called a metal vapor anodic arc, the arc voltage is just higher than the ionization voltage of the metal atoms in the range of about 8 V. However, even if the driving voltage of the circuit is less than 8 V, this voltage can be induced by the inductance present in any electric circuit. Although material transfer happens in both directions, a net material transfer from the anode to the cathode can be observed.

At a certain gap length of about 0.5 to 1 µm, the anodic arc can no longer be sustained, but, the anodic arc abruptly charges into a cathodic arc. The metal vapor cathodic arc requires a much lower metal vapor density, which is mainly sustained by the evaporating cathode spot of high current density. The cathodic arc is characterized by a lower density of excited atoms, less radiation and an arc voltage of 4 to 5 V higher than the anode arc. The lifetime of the cathodic arc is limited, depending on the volume of the molten bridge and the opening speed of the contacts. The net material transfer of the cathodic arc is from the cathode to the anode. These two types of arcs are important for Telecom and Signal Relays.

c) Closing contacts

Basically the same effects and same type of arcs occur in closing contacts. Between approaching contacts, an arc can be ignited by a dielectric breakdown or by evaporation of a metal bridge.

While the breakdown voltage is determined by the e.m.f. of the circuit, the inrush current due to the discharge of the capacitance parallel to the contact gap may be far beyond the steady state current of the circuit after closure. Field emission breakdown may occur within 1ns. At a breakdown field strength of 20 to 500 V/µm and a closing velocity of 1...2 m/s at a 125 V source, a make arc duration in the range of less than 1 µs may result. Even this short time is enough to cause material transfer. In the event of bouncing, the same effects can occur as during the opening of contacts.

Another effect might be of importance while contact is being made. When the contacts are closing and the contact surface is molten due to a preceding arc, the contacts might weld. Depending on the opening force, these welded metallic bridges might be broken. If the contact force is not sufficient to break the weld, sticking occurs. During separation, a material transfer from the anode to the cathode can be observed.

For typical loads switched by Telecom Relays with contact gaps in the range of 0.25 mm, maximum switched voltage of 220 Vdc, opening and closing velocities of about 1 ... 2 m/s, it is primarily the effects from a metallic vapor arc which can be expected.

6. Electrical Endurance

Telecom and Signal Relays have an extremely large working load range. These can be divided into several typical load areas. In every load area, different physical phenomena are effective with different physical effects influencing the performance of the relay contacts.

No load
Switching in this area means to have absolutely no arcing. The maximum voltage applied is less than the softening voltage of the contact materials used. An increase of the contact resistance can only occur by corrosion or polymerization effects.

Low load
Two effects are important in the low load range. Even though the voltage is lower than the arc voltage, short arcs with very low energy still occur. The second effect is that during breaking the contact, the temperature in the constriction area increases up to the boiling temperature of the contact material. A typical effect in this range is the generation of carbon as the short arcs are breaking the hydrocarbons in the switching atmosphere, but the arc does not have enough energy to burn the carbon.

Intermediate load
In the intermediate range, short arcs and discharges of cables are the most common effects. Depending on the energy of the discharge, contact erosion can happen. The arc has enough energy to burn the generated carbon on the contacts.

High load
On practically all these loads, arcing can be detected. Depending on the voltage and current, switched contact erosion or material transfer is the dominating effect.
Depending on the load applied, erosion or transfer of contact material are the effects which can be seen.

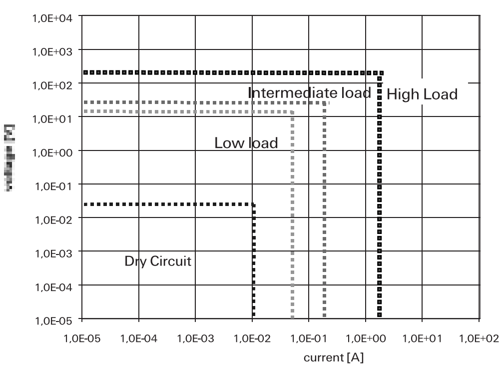


Fig. 18: Working load ranges for Telecom and Signal Relays

a) Test procedure
After each operation, the contact resistance, the insulation resistance and bridging (shorting between normally open and normally closed contact) were monitored. While the contacts are switching the defined load, the measurement of the contact resistance was done under dry circuit conditions (max. 30 mV/max. 10 mA). When the contacts have closed during a test cycle, the test load is disconnected and a measurement circuit with an open circuit voltage of maximum 30 mV is connected for the contact resistance measurement. After the measurement, the measurement circuit is disconnected, the load connected and the contact operates with the defined load. Performing the contact resistance measurements under dry load conditions gives the highest possible sensitivity for all kinds of contact failures.

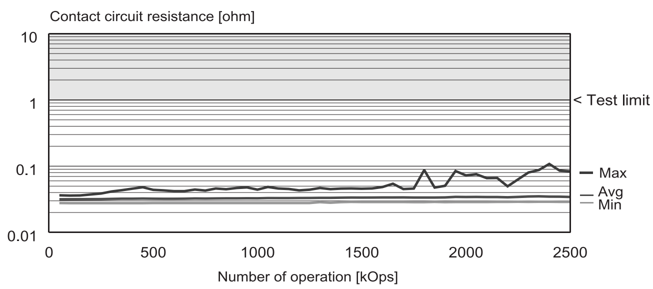


Fig. 19: Typical result obtained from an electrical endurance test (Contact application 0, max. 30 mV/ max. 10 mA), 2.5 million operation. The three graphs represent the minimum, average and maximum values obtained from 20 contacts, which gives 50 million readings in total.

Detailed test results obtained from electrical endurance tests are given in the related IECQ/CECC test reports which are available on request. Further test results on other loads are available from application engineering.

b) Failure criteria
During electrical endurance testing, a certain number of failures are allowed. Typical are 1 to 10 failures during 1 million operations. A failure is defined as:

- contact resistance value higher a certain limit (> 1 Ω)
- insulation resistance less a certain limit (<100 kΩ)
- bridging resistance lower than a certain limit (<100 kΩ)

The above-mentioned values are typical for linecard loads, but generally depend on customer specifications.

7. Contact materials

To achieve optimum contact performance, the combination of contact material, atmosphere and gas tightness, switching loads, contact characteristics such as contact force and contact dynamics has to be considered. Only welded contacts are used in modern designs for use in Telecom and Signal Relays. Contact rivets cannot be produced and handled in the small dimensions required. Therefore, contact materials are produced in tapes, then cut and welded to carrier and springs.
The selection of the contact material is dominated by cost considerations. Different techniques are applied to minimize the cost for precious metals without a negative impact to the reliability of the relays.

For Telecom and Signal Relays mostly gold coated bifurcated contacts are used, especially for low level switching. Three different methods are used to bring the gold to the base material, rolling, galvanic deposition and sputtering. The performance of sputtered gold layers compared to rolled or galvanic deposited gold layers is superior. The major advantages of the sputtered gold layers are the absolute cleanness of the surface and the positive effect on material transfer. On sputtered gold layers the ignition of the arc takes place on different points which are distributed over the whole contact area. As a result the contact erosion is well distributed and less severe. The performance of different gold alloys is shown in table 3.

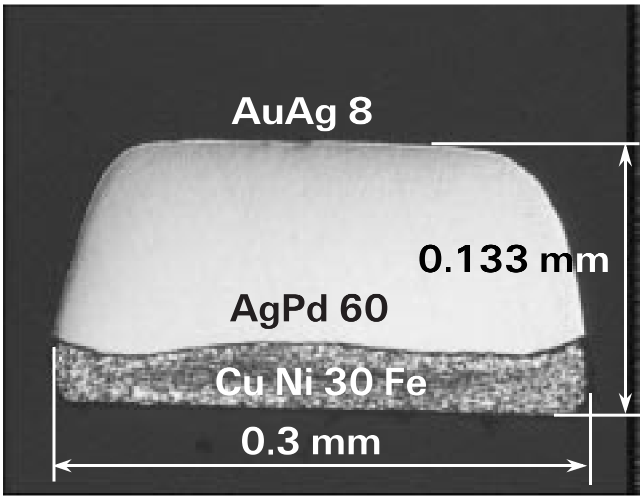


Fig. 20: Typical dimensions and cross section of a 3-metal layer contact tape. Depending on the dimensions, up to 5 layers can be produced.

Contact material	Advantages	Disadvantages
Au	High conductivity. 44MS/m Corrosion protection	Very soft, HV 20 Contact welding
AuAg 8 ... 10	High conducting reliability	Formation of Ag-Sulfur , sticking
AuNi 2 ... 5	With DC no material migration	Contact welding Formation of NiO_2
AuPd 2 ... 4	High erosion protection	Fretting corrosion (polymerization)
Au Co 0.2 ... 0.5	With DC no material migration	Oxidation of Co

Tab. 3: Gold and gold alloys for the use in Telecom and Signal Relays

Contact material	Advantages	Disadvantages
Ag	Hight conductivity 60MS/m Very cheap	Formation of Ag-Sulfur, sticking
AgNi 0.15	High strength	Formation of Ag-Sulfur, sticking
AgNi 10 ... 20	High erosion protection	Contact welding, material transfer
AgPd 60	Largely resistant to sulfur	Fretting corrosion (polymerization
PdRu 10	High conducting reliability	High cost
PdNi 30	Low material transfer	High cost
$AgCdO/AgSnO_2$	High erosion protection at high current (power circuit breaker)	High contact resistance

Tab. 4: Silver and silver alloys for the use in telecom circuits i.e. ringing load, cable load, etc.

Most of the telecom relays are back-filled with nitrogen. As usually the plastic housing is not gastight, after a few days normal air is inside the relays.
Standard contact materials for telecom relays switching in an air atmosphere are
- AgNi 10 .... 20 + Au
- AgPd 30 .... 40 + Au

For most applications the contact material is plated on both contacts with a thin gold layer. For the best switching performance in air the use of silver–palladium with 60% palladium is the most sophisticated solution as it offers
- good corrosion characteristics
- good erosion characteristics
- high resistance against material transfer

For many applications in telecommunication also silver-nickel give good results.

When relays are gastight, in order to protect the contacts from corrosion, also other materials can be taken into consideration. For example the combination of palladium-ruthenium in a SF_6 switching atmosphere gives superior contact performance to all other combinations of contact material and switching atmosphere, which were used so far.

VII. Dielectric

Although Telecom and Signal relays are designed to switch low voltages and currents, they frequently have to handle electromagnetic interference such as:

- *lightning* – the most critical stress is usually generated by induced lightning, as a direct hit is not usual and would cause damage in any case regardless of the protective measures taken.
- *direct connection* to the main circuit (power cross) - causes maximum voltage of less than 600 V, which is not critical.
- *inductive coupling from the main circuit during power faults* - high currents flowing in power lines can induce high voltages in adjacent communication cables.
- *ground potential rise* - happens when heavy ground currents flow in the common ground connections during power faults cause substantial difference in the potential (more relevant in US and Asia).

For the design of the insulation system of a relay, only the relevant physical phenomena for short-term application have to be taken into account, where three different types of insulation have to be considered:

- solid insulation
- gaseous dielectric clearance
- gas/solid interface creepage

For solid material, the intrinsic dielectric withstand voltage is relevant. It is approximately two orders of magnitude higher than that of gases (approx. 30 kV/mm). Therefore, the insulating properties of the solid insulation material are not relevant for the dielectric limits of a relay, but important in order to fulfill the safety requirements.

Since the Bellcore (now Telcordia) requirements were introduced, a 2500 V pulse between coil and contacts is necessary. For the design of telecommunication systems, the same values between open contacts are relevant.

To achieve high dielectric and surge values at the same time as a more compact design is extremely difficult. While a solid insulation material can be used between coil and contacts and between adjacent contacts, this is not possible between open contacts.

In gases, dielectric breakdown is started if the electric field stress is sufficiently high to start electron avalanches which finally build a bridge across the gap enabling a conducting breakdown channel. For air, a field strength of approx. 2.44 kV/mm is necessary at an ambient pressure of 100 kPa. This value of 2.44 kV/mm is the so-called

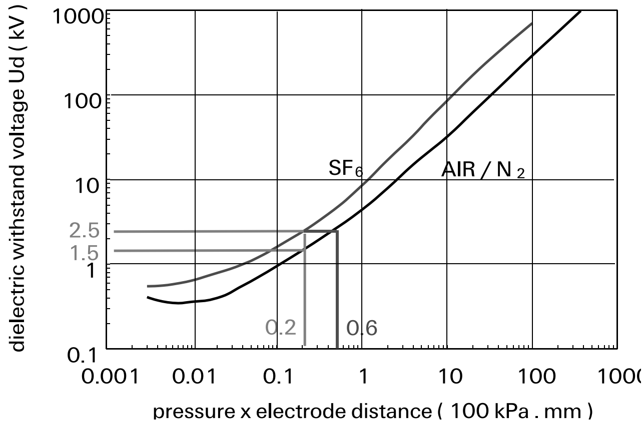


Fig. 21: Paschen curve for air and SF_6. With a distance of 0.2 mm at normal pressure (100 kPA), a dielectric strength voltage of 2500 V in SF_6 and 1500 V in air can be achieved. Alternatively 2500 V can be achieved by increasing the pressure in the air from 100 to 300 kPa (at a distance of 0.2 mm) or increasing the distance to 0.6 mm at normal pressure.

theoretical withstand voltage strength of air. Change of pressure causes a proportional change to this theoretical withstand voltage. Based on this theoretical value, the dielectric strength for an electrode gap of length s with an ideally homogenous field and an ideally smooth electrode can be calculated. The results are presented in Fig. 21 in what is known as the Paschen curve.

A. Dielectric withstand voltage of a contact gap.

Due to inhomogeneity in the contact geometry and due to the surface roughness of technical contacts, a homogenous field can never be expected in a contact gap. As a consequence, the field stress is higher in a technical contact gap. Computer simulations have shown that a reduction of about 30 % has to be considered for real designs.

B. Dielectric strength of an interface surface solid – gas

For clean and smooth surfaces, the solid material does not significantly interact with the breakdown process in the gas. Therefore, theoretically the withstand voltage strength at the surface of the solid material exposed to a tangential electrical field is more or less the same as that for the pure gas gap. However, as the solid material is not ideally smooth and its surface always contains a certain degree of pollution in the technical devices, dielectric breakdown can be expected across the surface rather than in the gas at a slightly reduced voltage compared to the breakdown voltage of a pure gas.

C. Consequences

As a consequence of the above considerations, the dielectric integrity of a low voltage switching device is determined by two major parameters:

- design geometry
- theoretical withstand voltage capability of the insulating plastics and especially of the insulating gas

To improve the dielectric performance, the easiest ways are to either increase the gaps, include insulating materials or increase the dielectric withstand capability of the gaseous dielectric. Unfortunately, an increase in the distances is not possible due to the miniaturization of the relays. The introduction of solid materials between open contacts also does not solve the problem.
In addition to the homogeneity of the electric field, the dielectric strength voltage depends on:

- the distance between conducting parts
- the gas pressure
- the type of gas

Filling relays with electronegative gases significantly increases the dielectric performance of the relays. The housings of those relays are designed so as to keep the gas filling during the entire lifetime, which is defined to be at least 25 years. In simulation tests, up to 350 years were achieved (Fig. 24).

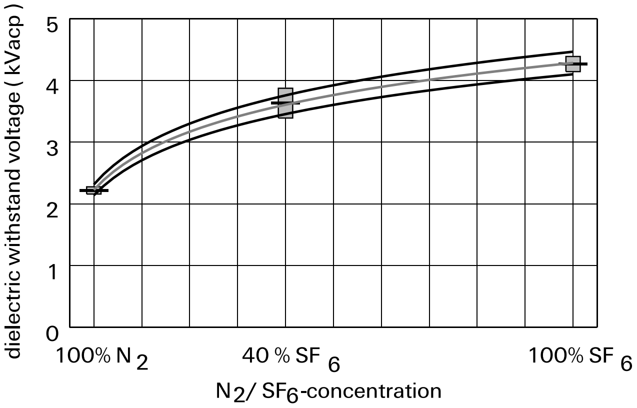


Fig. 22: Dependence of dielectric strength between coil and contact system on SF_6 concentration.

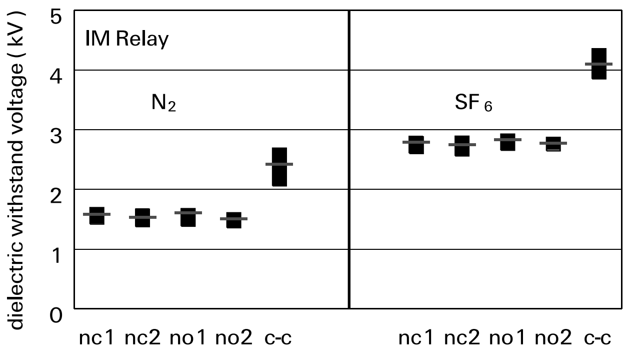


Fig. 23: Comparison of the AC withstand voltage (peak values) of IM relays filled with N_2/air and SF_6 (pressure 100 kPa) between open contacts: nc = normally closed, no = normally open - between coil and contact system: c-c = coil to contacts. (Minimum, maximum and average values are presented.)

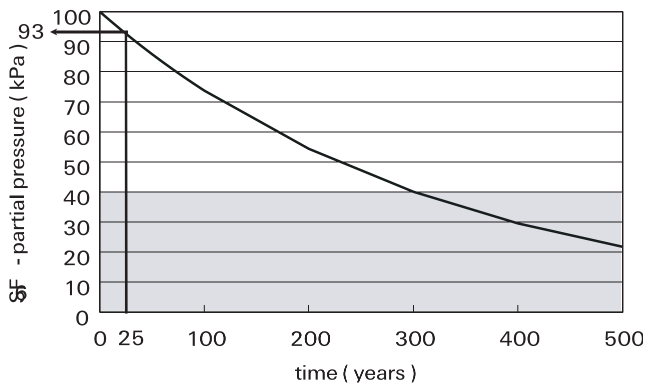


Fig. 24: SF_6 loss of the FX2 relay as a function of time. After 25 years, approx. 93% of the SF_6 filled would still be present, whereby the 93% solely reflects the accuracy of the measuring device. In reality, it was not possible to detect any extraneous gases.

D. Dielectric and surge requirements

The **dielectric** measurements can be defined and measured with AC or DC voltages. The factor between AC and DC values is just the v2. When the dielectric values are defined with DC, polarity effects have to be taken into consideration. The supplier has to ensure that the measurement is performed with the polarity giving worst case results. The duration of measurement is 1 minute in laboratory or quality assurance tests, in the range of less than 1 s in the in-process measurements.

The **surge or impulse voltage** measurements are performed with pulses of defined shape. The most common

applied pulses are:
- 1.2 µs / 50 µs or 2µs / 10 µs
- 10 µs / 700 µs or 10 µs / 1000 µs
- 10 µs / 160 µs

The first value in the pulse gives the virtual front time, the second value gives the virtual time to half value as shown in Fig. 25.

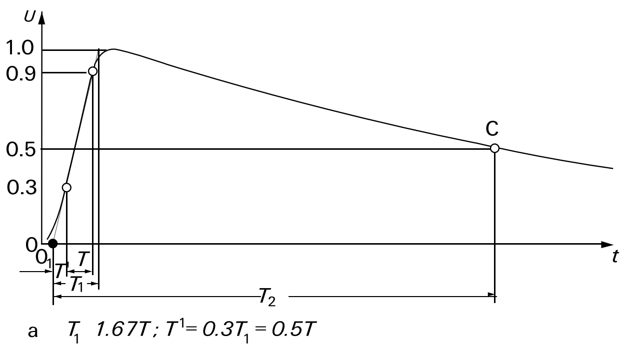


Fig. 25: Definition of the virtual front time T1 and the virtual time to half value T2.

The dielectric values as well as the impulse voltage values are defined between:
- open contacts / contacts of the same pole
- adjacent contacts / contacts of different poles
- coil and contacts
- coils (double coil types)

The current surge measurements are performed with the same pulses as the voltage surge measurements. The major difference is that during current surge testing the relay contacts are closed and have to carry the short circuit current. The peak current during this test may provoke contact welding. The critical parameter is more the amplitude than the duration of the pulse. Depending on the resistance of the circuitry current peaks, up to 500 A can occur.
Depending on the standards, the circuitry has to comply with different requirements that must be fulfilled (Tab. 5).
The most important standards that Telecom Relays have to comply with are:
- IEC standards
- Bellcore GR1089
- IEC 60950 / UL 1950
- UL 508
- ITU T K recommendations

Standard	Dielectric test	Impulse voltage test	Impulse current	Clearance & Creepage
IEC/EN 61811 series	yes	yes	no	no
IEC/EN 60950, UL	yes	yes	no	yes
UL 508	yes	no	no	no
Bellcore/Telcordia	no	yes	yes	no
ITU T K20	yes	yes	yes	no

Tab. 5: Dielectric, impulse voltage current and voltage and clearance and creepage requirements required in different standards

VIII. Environmental conditions

Relays are subjected to shock, vibration, climate, fire, sealing and magnetic interference tests to ensure reliable function under a wide range of environmental conditions. The procedures are described in the IEC 60068-2 series.

A. Shock and vibration

Electromechanical relays can fail under exposure to excessive mechanical shock and vibration. The displacement of movable parts inside the relay can lead to a malfunction, which is defined as an opening of closed contacts or a closing of open contacts for more than 10 µs. The relay is damaged when the functional parameters exceed the specified values. Telecom and Signal Relays are high shock and vibration resistant basically because of their low mass. But the design also has an impact. The symmetrical design of the armature in polarized 2 form c relays makes them more resistant than non-polarized relays.

The values in this data book refer to short-term stress occurring during transportation, handling and operation. The relays should not be operated in an environment producing constant shocks or vibrations near its limits.

The shock resistance is tested according to IEC 60068-2-27 with a half sinus wave. The acceleration and duration of the shock defines the severity. Typical values are: 30 G / 18 ms, 50 g / 11 ms and 100 G / 6 ms. The test is carried out in all 3 axes over a limited time period (e.g. 10 shocks or 10 times the frequency rang).

The vibration resistance is tested according to IEC 60068-2-6 with a sinus wave. The acceleration is given in G (10 m/s^2) for a defined frequency range. For low frequencies (approx. 10 to 60 Hz), the test is carried out with a constant amplitude. As a consequence, the acceleration rises with the frequency and reaches the specified value at the upper frequency range (approx. 60 Hz). At that frequency, an amplitude of 0.75 mm equals 10 G, 1.5 mm equals 20 G, etc. Above that frequency, the acceleration is held constant. The test is carried out 10 times, sweeping from minimum to maximum frequency in all 3 axes.

B. Climate tests

Relays are used in a wide variety of applications. Far from climate controlled cabinets, they are subjected to different climatic conditions. Most common for Telecom Relays today is an operating temperature range from –40°C to +85°C. Because the test conditions are named in detailed customer specifications, they vary from customer to customer. For example, temperature tests defined by a telecom customer are listed in Tab. 6.

Requirements for applications other than communications are tested on demand. Examples for the automotive sector are extended temperature range, salt mist and corrosive gases tests.

Test	Condition	IEC publication
Cold	500 h at – 40°C	IEC 60068-2-1, Test A
Damp heat (steady state)	21 d at 40 °C / 93 % relative humidity	IEC 60068-2-3
Dry heat	2000 h at +85 °C	IEC 60068-2-2
Change of temperature	- 40 °C / +100 °C, 50 x 3 cycles / h	IEC 60068-2-14

Tab. 6: Temperature tests definded by a telcom customer

C. Sealing

All AXICOM relays, except some cradle relays, are sealed relays. The sealing prevents the surrounding atmosphere from penetrating the relay. A common test is to collocate the relay into a liquid (water) at a temperature of 1 to 5 °C above the maximum ambient temperature of the relay. A leakage will be seen as air bubbles (IEC 60068-2-17, test Qc method 2). The protection class according to IEC 61810-7 part 2.2 is RT IV. Some relays are filled with ENG (Electro Negative Gas). Since the ENG is important for the dielectric breakdown voltage of the relays, the sealing fulfills the highest protection class RT V (hermetically sealed relay) ensuring that the ENG stays in the relay over decades.

D. Flammability

The flammability test is carried out with a needle flame applied to the relay cover for 20 seconds. If not otherwise stated, the allowable burning time is 30 seconds after the flame is removed from the relay. The procedure is defined in IEC 60695-2-2.

A material's resistance to burning is expressed by its oxygen index. The value represents the minimum concentration of oxygen (expressed as percent by volume) in a mixture of oxygen and nitrogen that will support flaming combustion of a material that is initially at room temperature. A higher value indicates a less flammable material.

The UL 94 rates only materials and not whole relays. The material probes have a defined thickness (e.g. 0.25 mm). The flammability is classified in V0 (best), V1, V2, HB (worst).

E. Magnetic interference

The operate and release voltage of a relay can be affected by external magnetic fields of adjacent relays or other magnetic components. For relays, the impact depends on the distance between the relays, the number of adjacent relays and their excitation. A distance between the relays of 2.54 mm (0.1 inch) is usually enough so that the relay will work inside the specified operating voltages.

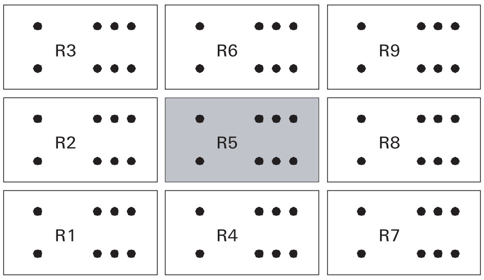


Fig. 26: Relay configuration (adjacent relays)

On a quantity basis, the impact of a magnetic field is tested by exposing the relay to a linear magnetic field inside a test coil. To pass the test, the operate voltage change should be less than 20% and the release voltage change should be less than 40%.

IX. Processing

A. 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 on the inside as well as the outside of the relay. SMT relays have to be dried before the soldering process to prevent damages cause by evaporating humidity absorbed in the plastic This is done in the preheating zone of the SMD oven.

Increasing contact resistance over a time period, due to the formation of oxides and other layers, is to be expected for most contact materials. This degradation is dependent on the ambient atmosphere and is more rapid at high temperatures. Special care has to be taken if relays are tested or used with low contact loads after being stored for prolonged periods. Deterioration of contact resistance during storage is reduced in the case of plastic or hermetically sealed relays.

B. Transport

In transit, 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). If mechanical stress is suspected, the relay should be checked and tested before use.

C. Packaging

Different packaging is used depending on the relay type and with regard to any specific requirements during shipment or production. THT relays are packed in plastic tubes while the standard packing for SMT relays are blisters wounded on a reel (tape & reel).

D. Handling

Modern relays are high precision components that are sensitive to mechanical stress and abusive handling. Care must be taken when handling the relay during all stages of production.

E. Testing

During incoming inspection, special care has to be taken not to bend the relay terminals. Internal failure (e.g. breaking of coil wires) or the degradation of sealing properties could be the consequence.

F. Automatic handling

The handling pressure or force of automatic feeders or robots has to be adjusted to avoid mechanical damage such as cracking the relay case. The design of the relay should be such that when held by its case or inserted into a socket, it does not become detached.
Due to the reduced size of modern Telecom and Signal Relays, they can be placed by pick and place machines with a speed similar to passive PCB components. It is possible to use a mechanical as well as vacuum picker.

G. Insertion

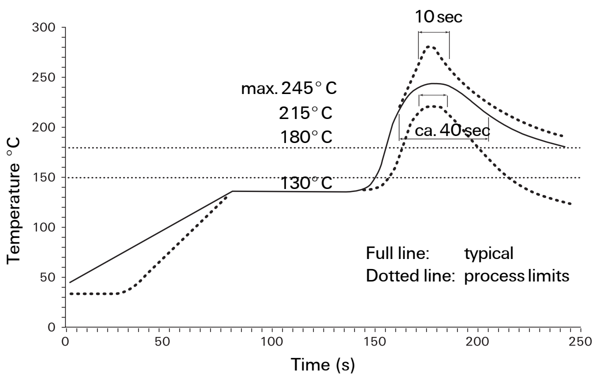
When inserting the relay into the PCB, do not press or use undue force on the pins as this may compromise the pin seal or affect the integrity of the coil connections.

H. Clinching

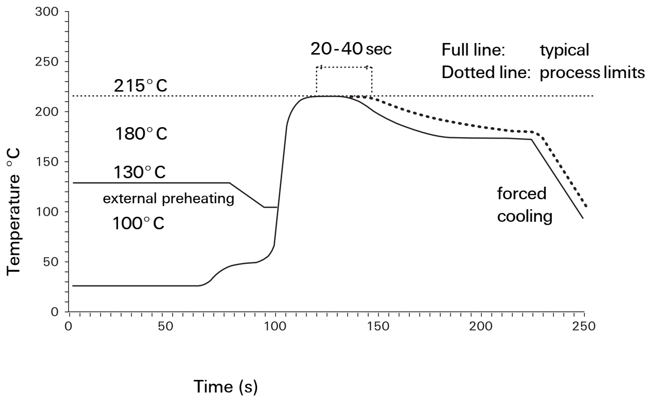
Terminals should not be bent to hold the relay in place on the PCB to aid flow soldering. Bending or cutting the pins after insertion generates extreme mechanical stress, especially in the case of rectangular PCB terminals. Neither the relay performance nor sealing of flux resistant and plastic or hermetically sealed relays can be guaranteed if the terminals have been bent.
Self-clinching terminals are available for some types of PCB relays.

I. Fluxing

Fluxing has to be carefully considered depending on the type of relay. Unsealed 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 should be set so that it cannot flood onto the PCB. This is particularly critical if the PCB is dual tracked and there are unused holes under the body of the unsealed relay. Flux resistant and sealed relays may be used with most fluxing procedures due to the seal between the pins and the relay base. The PCB should not be flooded as normally only the pins are sealed and flux could possibly penetrate the relay by capillary action between the relay cover and base. If there is any doubt about the fluxing process, fully sealed relays (plastic or hermetically sealed) should be used.



Infrared Soldering: Temperature/Time Profile (Lead Temperature)



Vapor Phase Soldering: Temperature/Time Profile (Lead Temperature)

Fig. 27: SMT soldering profiles

Soldering technology	Temperature stress	Effects
Infrared (IR)	*High to very high* Radiation temperature >> soldering temperature	Housing warmer than terminals DT on board over 40°C
Convection	*High to very high* Gas temperature >> soldering temperature	*Homogeneous heat distribution, no shadows* ΔT on board over 15 °C
Combination (IR + Convection.)	*High*	Nearly no shadows ΔT on board over 25 °C
Vapor phase (VP)	*Low* Vapor temperature = soldering temperature	*Homogeneous heat distribution*

Tab. 7: Impact of soldering equipment on relays

J. Preheating

Before flow soldering, the entire PCB should be preheated. This is to dry the flux and prevent it from penetrating the relay during soldering. Also, better quality solder joints are achieved as a result of more uniform temperature distribution. Preheating should be carried out at 100°C for approximately 1 minute. Excessive exposure to high temperatures may affect the relays characteristics.

K. 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 bath temperature should be 260°C maximum and the soldering time should not exceed 5 seconds. The solder level has to be adjusted so that it does not flood the printed circuit board surface.

L. SMT soldering

The soldering should be carried out according to the recommendation of CECC 00802 if not stated otherwise in the respective datasheet.

M. Hand soldering

If the relays are soldered by hand, the process should be completed as quickly as possible. The same temperature and time limits apply as for wave soldering.

N. Cooling

After flow soldering, the assemblies should be cooled in order to reduce thermal stress and to minimize the pressure differential between the inside of the relay and the atmosphere. If the relay sealing breaks, cleaning fluid along with dissolved flux will be sucked inside the relay if a pressure differential exists. Ingress of flux into the relay can either cause the armature to stick, preventing operation, or contamination of the contact surfaces leading to contact failure.

O. Chemical cleaning

In modern PCB assembly less and less cleaning is used. If cleaning is necessary, certain precautions have to be taken.
1. Unsealed relays: Only the base of the PCB should be cleaned to prevent penetration of solvent and dissolved flux into the relay. Any other cleaning method involving potential contamination of unsealed relays should be avoided.
2. Flux resistant relays: Immersion cleaning is not possible with these types of relays. Only the soldered side should be washed and care has to be taken not to allow washing solution to flood the PCB surface.
3. Sealed relays: Only fully sealed relays should be immersion cleaned. Even then the PCB should be allowed to cool before the washing process in order not to damage the seal due to thermal shock or pressure differential. When using high pressure cleaning processes, special care has to be taken to avoid any ingress into the relay. Liquids under high pressure can damage the seal of the relay. Ultrasonic cleaning is not recommended as this can cause friction welding of the contacts, especially in the case of gold-plated contacts. If ultrasonic cleaning cannot be avoided, it should be completed as quickly as possible.

Modern cleaning equipment uses water or alkaline solutions, which are more environmentally friendly than CFC's. 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 acetone, ethyl acetate, aqueous alkalines, phenolic combinations, thinner-based solvents, chlorosene-based solvents, trichlene-based solvents and chlorine. Fluor-based cleaning solvents like Freon are forbidden today.

X. Standardization

Standardization is valuable for relay manufacturers as well as relay users. It helps create multi-source products.
For Telecom and Signal Relays, standards from different standardization bodies are of relevance. The standards that have to be considered mainly depend on

- type of application
- region where the device is used

In order to have products that can be sold worldwide, relays should cover all relevant standards.

A. Standardization organizations

1. IEC – International Electrotechnical Commission

IEC standards are actually the best maintained standards for Telecom and Signal Relays. They are well supported by Asian and European countries as well as Australia, but much less from US and Canada.
Internet: www.iec.ch

2. CENELEC – Comite Européen de Normalisation Electrotechnique (CENELEC)

European standardization body. Since the Dresden agreement between IEC and CENELEC, all IEC standards will become European standards (EN) at the same time. there will be no individual national standards in Europe anymore.
Internet: www.cenelec.org

3. National Standardization Bodies

National standardization bodies do not introduce their own standards, but they do participate in the international standardization work.
Internet: www.ansi.org , www.bsi.uk, www.deke.de, www.ute.fr

4. UL – Underwriters Laboratories

UL standards are focused on safety-related questions. Certain standards are harmonized with the IEC standards (IEC 60950 – UL 1950).
Internet: www.ul.com

5. CSA – Canadian Standard Association

CSA standards are more or less identical with UL standards.
Internet: www.csa.ca

6. MIL – Military Standards

MIL standards were one of the earliest standards. Due to the decreasing importance of the military sector, these standards has lost their importance. Additionally, relay relevant MIL standards are not very well maintained and therefore obsolete. However, especially in North America, they are still important.

7. ITU-T - Telecommunication Standardization Sector of International Telecommunication Union

ITU papers are only recommendations. As most telecommunication equipment manufacturers follow them, they also have the character of a standard.
Internet: www.itu.int

8. IPC – (Institute of Interconnecting and Packaging Electronic Circuits)

IPC standards are only recommendations, but in daily life they are considered to be standards.
Internet: www.ipc.org

9. Bellcore – Bell Communications Research / Telcordia

Bellcore is a part of the former Bell Laboratories. Today their name is Telcordia. Bellcore standards deal with the safety aspects of telecommunication systems.
Internet: www.telcordia.com

10. FCC Federal Communications Commission

Concerning Telecom Relays, safety aspects are the focus of this standard. It has remained unchanged for a long time (e.g. FCC Part 68: 1975).
Internet: www.fcc.gov

B. Types of standards

An overview over the numerous relevant standards which manufacturers and users of relays have to consider is given in Fig. 28. The standards can be divided into following categories:

1. General standards:

These are not related to a special product. Typically, these standards contain definitions, sampling plans, etc. General standards are valid for different types of products or product groups.

2. Relay standards:

Standards which describe the requirements for relays in general and in detail and indicate the specific test and measurement procedures.

3. Safety standards:

These standards describe the requirements for safety such as flammability, clearance and creepage distances for various types of equipment, the minimum switching performance and dielectric and surge characteristics. As relays are used as an interface between the electronic circuit and external connections, they also have to cover safety requirements. The most typical standard for relays in telecommunication is the IEC60950 "Safety of Information Technology Equipment, Including Electrical Business Equipment". This standard describes all rules on how to design and manufacture telecommunication equipment which fulfill the valid requirements.

4. Test standards:

Standards that describe the various test procedures in detail. These standards are not specific for relays or components. They are also valid for all types of equipment. These standards are very helpful for performing the required tests as they give detailed guidelines how to perform them.

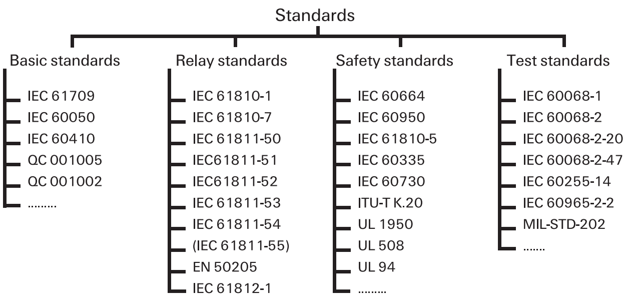


Fig. 28: Relevant standards for manufacturers and users of relays.

C. Most relevant standards for Telecom and Signal Relays

IEC61810-1 - Electromechanical non-specified time all-or-nothing relays - Part 1: General requirements:
Defines the basic requirements for relays.
IEC61810-7 – Test and measurement procedures: Defines the recommended procedures applied to the relays when tested.
IEC61811-50 – Sectional specification for Telecom Relays: Defines the minimum requirements for a Telecom Relay.
IEC61811-51- Blank detail specification for Telecom Relays of non-standardized types and construction: Applicable for all Telecom Relays that are not covered by another standard (MT4 relay).
IEC61811-52 - Blank detail specification for Telecom Relays with two changeover contacts, 20 mm x 10 mm base: Defines the characteristics of the 2nd Generation Telecom Relays (MT2 relay).
IEC61811-53 - Blank detail specification for Telecom Relays with two changeover contacts, 14 mm x 9 mm base: Defines the characteristics of the 3rd generation of Telecom Relays – flat or low profile type (FP2 relay).
IEC61811-54 - Blank detail specification for Telecom Relays with two changeover contacts, 15 mm x 7.5 mm base: Defines the characteristics of the 3rd generation Telecom Relays – vertical or slim line type (P2, FX2, FT2, FU2 relays).
IEC61811-55 - Blank detail specification for Telecom Relays with two changeover contacts, 10 mm x 7.5 mm base (max.): Defines the characteristics of the 4th generation Telecom Relays (IM relay).
Telcordia (Bellcore) GR1089: Defines the impulse-voltage and current requirements for telecommunication equipment. This is a system standard which is also applied to Telecom Relays, 2500V 2/10µs impulse applied to telecom ports and also to relays.
UL508 – Standard for industrial control equipment: Defines the characteristics of switching devices used in industrial applications - mostly safety-relevant. This standard is also applied for relays used in telecommunication equipment.
UL94 – Tests for flammability of plastic materials for parts in devices and appliances: Defines the safety-relevant properties of plastic materials, e.g. the flammability characteristics of plastic materials.
FCC Part 68 - Connection of terminal equipment to the telephone network: Of major consequence for relays coming from this standard is the 1500V - 10/160µs impulse voltage requirement between open contacts.
ITU-T-K.20 - Resistibility of telecommunication switching equipment to overvoltages and overcurrents: This also defines the dielectric and impulse-voltage and current requirements for a Telecom Relay.
Remark: The IEC255 series was recently re-numbered and today is ICE60255. Most publications relevant for Telecom Relays were superseded by the IEC61810 and IEC61811 series.

D. Insulation coordination

Basic standard for insulation coordination is the IEC60664 standard, which describes the basic requirements for insulating systems.
For telecommunication equipment, the IEC60950 – Safety of Information Technology Equipment, including electrical business equipment - has to be applied. For other fields of application, the related standards have to be considered.

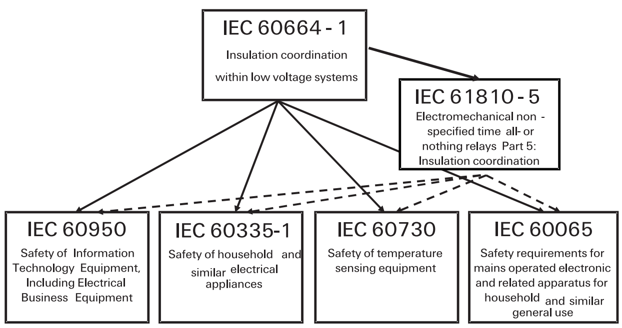


Fig. 29: Safety standards

The determination of the required insulation system for telecommunication applications is given in simplified form in Fig. 29.

- define types of circuits to be insulated (SELV, TNV, etc.) and the working voltage level
- determine the circuit type (primary/secondary)
- determine pollution degree (usually outside =2, inside relay =1)
- determine transient voltage level
- determine clearance and creepage distances
- determine required dielectric and/or impulse voltage testing

Defining the insulation system needs some practice. In case of questions, contact AXICOM application engineering.

XI. Reliability

Definition: The reliability expresses the probability of a relay continuing to meet the specified requirements over a given period of time or a given number of operations. Like most other electrical and electronic components, the failure rate of relays is not constant during the entire lifetime. The expected failure rate ? dependent on the number of operations is shown in the bathtub curve (Fig. 30).

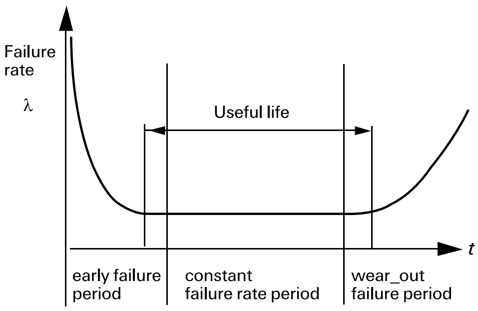


Fig. 30: Bathtub curve

The bathtub curve is divided into 3 phases:
Early failure period: Suppliers try to prevent this phase by using quality assurance measurements. Typical failures in this phase are:

- particles from manufacturing
- impact from the (SMD) solder process

Constant failure rate period: During this phase, the failure rate is constant and very low. Only random failures without any specific related reason will happen.
Wear-out failure period: Telecom and Signal Relays are built for a typical lifetime of 25 years. In most applications the wear-out phase is never reached. The most probable reasons for the end of life failure of a relay are:

- contact erosion
- increase of contact resistance
- parameter drift (functional voltages, timing)

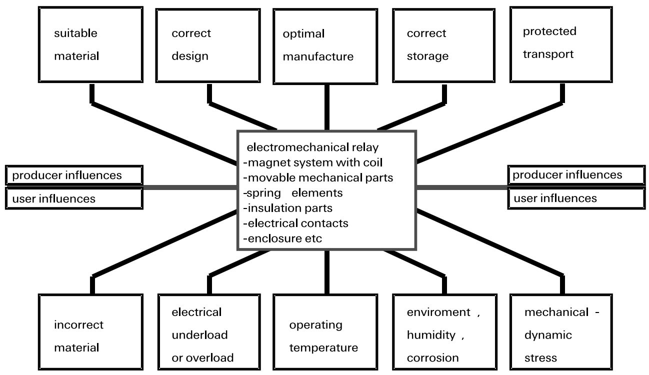


Fig. 31: Manufacturers and users influences on the reliability of relays.

Although Telecom and Signal Relays are based on a complex and highly precise electromechanical system containing moving parts, they are considered to be extremely reliable because:

- they can operate even in harsh environments
- they have a large switching range from µV and µA to A and 250V
- they have a low contact resistance in the closed state (mΩ) and high insulation resistance in the open state (MΩ)
- they have a high insulation between coil and contacts (>2500) V and between open contacts (up to 2500V)
- they are easy to use
- they are cost effective

As shown in Fig. 31, the reliability of relays is influenced by the manufacturer and the user.

A Characteristic values for reliability

The failure rate λ is given in number of failures per time or per number of switching operations.

MTBF Mean time between failures (time related)
$MTBF_c$ Mean cycles between failures (operations related)

The MTBF value is the mean time until a failure occurs. It is the reciprocal value to the failure rate and is given in hours:

$MTBF = 1/\lambda$

Typical values for Telecom Relays in monitored applications are:
$\lambda < 4$ FIT (10^{-9} hours)
MTBF > 30 000 years

In most cases only the MTBF value is given.

B Determination of reliability

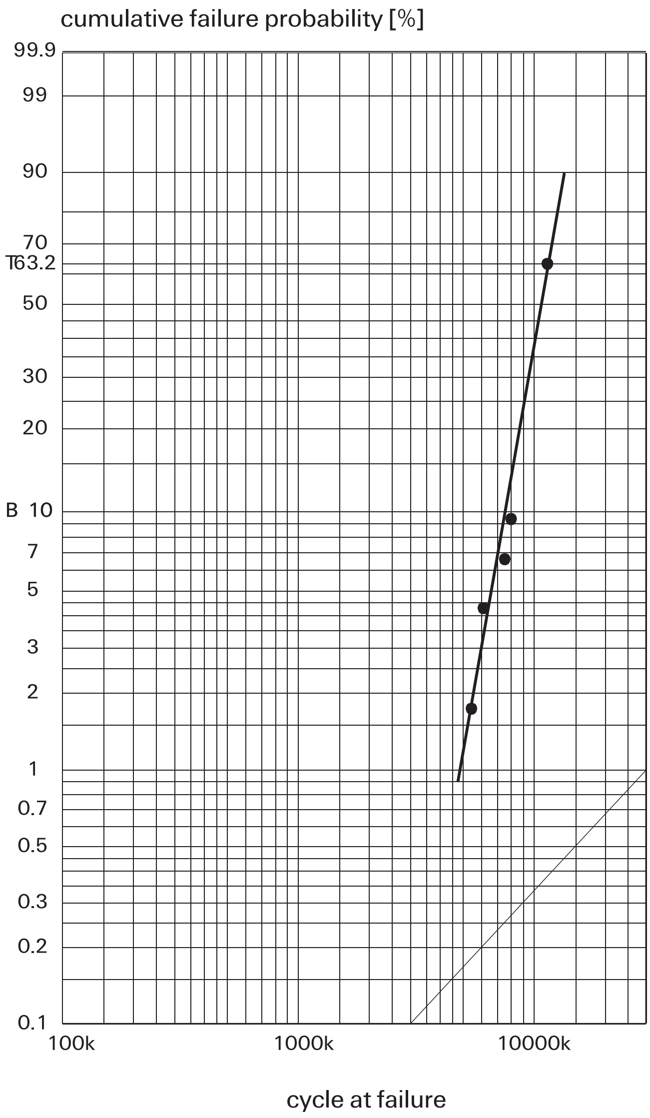
1. Weibull curve

The determination of the expected life under determined conditions can be done according IEC60255-23 by using a graphic method.

In practice during the IECQ/CECC tests, extended life tests are performed on a regular basis. From the values obtained, the Weibull chart is drawn and the characteristic values are determined.

Example: IM relay

Contact load: CA0
Number of operations: 8 million.



Relay # i	Failure number	Number of operations N x 10^6	Medium rank % (n=40)
11	1	5.3	1.7
15	2	6.0	4.2
4	3	7.1	6.6
2	4	7.9	9.1

Tab.8: Weilbull distribution data

→ $N_c = 11.5 \cdot 10^6$ operations
ß = -4.95
Mean $\mu = 0.935 \cdot 10^6 =$
$10.75 \cdot 10^6$ operations
Standard deviation $s = 0.16 \cdot 11.5\ 10^6 =$
$1.84 \cdot 10^6$ operations

N_C is the number of operations where 62.3 % of the relays have failed.
ß.. shape parameter gives an indication of which type of failure occurred.
ß < 1 early failures
ß = 1 random failures
ß > 1 wear-out failures

Remark: According to the IEC detail specifications, during extended assessment three times the defined number of operations must be performed. For a correct determination of the Weibull curve at least 10 failures should be recorded. Due to the excellent performance of electromechanical relays, the required number of failures often are not reached within a suitable test period.

C Theoretical determination

The theoretical determination is given in the IEC60979 standard. The basic idea behind this is a stress model. Based on an expected reliability under reference conditions, the following stress types are considered to have an impact on the reliability:

- type of electrical load
- switching rate
- temperature

$$\lambda = \lambda_{ref} \cdot \pi_{ES} \cdot \pi_S \cdot \pi_T$$

λ is the failure rate under operating conditions
λ_{ref} is the failure rate under reference conditions
π_{ES} is the electrical stress factor
π_S is the switching rate factor
π_T is the temperature factor

XII. Quality system

Customer satisfaction, profitability and market leadership are driven in large part by delivering quality products and services to customers. To achieve these targets is the goal of the AXICOM quality system. Continuous improvement in the quality level is necessary to meet the customers' expectations.
An overview of the quality relevant factors is given in Fig. 33.

Fig. 33: Quality relevant factors.

In order to achieve the required quality, many different factors must be considered. System requirements have to be fulfilled in order to guarantee a well-organized process. Nevertheless, the best quality system is no guarantee for high quality products with a low rate of defectives.

The quality system of AXICOM consists of following:

- Quality system according ISO 9000: 2000
- IECQ / CECC Manufacturer Approval
- Product Qualification
  - IECQ 160501 ... 160505
  - CECC 16501 ... 16505
- Safety Approvals
  - UL 508 / UL 1950
  - CSA
  - IEC/EN 60950

A IECQ/CECC SYSTEM

IECQ and CECC are identical quality confirmation systems for electronic components with reciprocally recognized certificates. While the ISO9000 system is covering the quality system requirements, the IECQ/CECC system is focused on product performance and quality.
To be certified by the IECQ/CECC system, the following points must be fulfilled:

- the quality system must meet the requirements of ISO 9000: 2000
- the manufacturing processes or procedures have been assessed and approved
- suppliers declaration of product conformity under third-party supervision

The system is based on the two basic elements of standardization and certification.

1. Standardization

IEC (International Electrotechnical Commission) provides a full range of international valid and well-maintained standards, which are the base for the certification of electronic components.
Within this system, blank detail specifications are provided which allows the generation of detail specifications for specific products. These blank detail specifications, which contain the technical description and requirements for inspection, testing and release of components. A detail specification is usually written by a supplier/user of this type of components. It is permitted to add additional tests and to increase the requirements – but never to relax them.

2. Certification

For Telecom Relays certified within the IECQ/CECC system – the Qualification Approval is applicable to a component which meets the requirements of an accepted detail specification. The approval consists of two major parts.

a) Manufacture's approval
The basis for this approval is the ISO 9000 certificate. Additionally, the manufacturer's approval establishes the obligation to be informed about all process and material modifications in relay manufacturing. The necessary actions are defined between the certification body and the manufacturer.

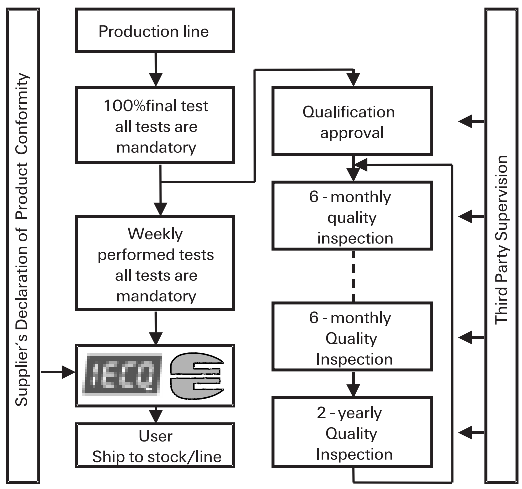


Fig. 34: Flow chart for IECQ/CECC approved components.

Test	Time sequence every week	1 year	2 year	Allowed # of failure
Visual inspection	x	x	x	0/2
Coil resistance	x	x	x	0/2
Contact-circuit resistance	x	x	x	0/2
Functional tests	x	x	x	0/2
Timing tests	x	x	x	0/2
Sealing	x	x	x	0/2
Check of dimensions	x	x	x	0/2
Contact dynamic dielectric test	x	x	x	0/2
Electrical end., miss-free accept.	x	x	x	0/2
Solderability	x	x	x	0
Dielectric test		x	x	0
Impulse voltage test		x	x	0
Insulation resistance		x	x	0
Sealing			x	0
El. End., cable load		x	x	0
El. End., rated contact voltage			x	0
El. End., rated contact current			x	0
El. End., cont.appl.0		x	x	0
Thermal endurance			x	0
Climatic sequence			x	0
Damp heat steady state			x	0
Robustness of terminals			x	0
Shock			x	0
Vibration			x	0
Mechanical endurance			x	0
Overload current			x	0
Overload voltage			x	0
Magnetic interference			x	0
Resistance to cleaning solvents			x	0
Fire hazard			x	0
Weighing			x	0
Thermal resistance			x	0
Rapid change of temperature			x	0
Resistance to soldering heat			x	0
Contact-circuit resist. stability			x	1

Tab. 9: Tests and allowed defects for the periodically performed quality inspection tests. Although a single failure is permitted during qualification approval on one test, during the quality inspection tests, AQL levels are still used.

b) Qualification approval

After having the manufacturer's approval, the qualification approval process can start. In the first step, the manufacturer has to write or to use an already existing detail specification, which must include at least the requirements from the blank detail specification.

The production of the related relay must be stabilized, which means the yield in manufacturing must be better than 90%.

As a normal procedure for a third party approval, an external inspector from an approval authority supervises the entire process. An overview is given in Fig. 34.

The relays that have passed the final test are taken directly from the line or stock. Therefore, the sample is representative for the actual production. The relays are divided into test groups and tested according to the valid detail specification. On most tests, zero failures are allowed (Tab. 9), which means that during the entire test series, no failures nor values outside the defined limits are allowed.

After successful finalization of all tests, a publicly available test report is made, an approval certificate is issued and the products can be marked as IECQ/CECC approved components.

With the successful qualification a whole range of further activities are established. In addition to the final tests, a weekly sample has to be taken to check the most important characteristics (Fig. 34). Every six months, a quality inspection, including the most important endurance tests, dielectric and impulse voltage tests, etc. has to be performed under the same conditions as the qualification approval.

Every two years, a full requalification must be performed. Material changes and process changes during the product life are approved during the quality inspections performed every six months. Missing one of the quality inspections means losing the qualification approval and the right to mark the relays with the IECQ or CECC logo.

c) Advantages of the IECQ/CECC system

The IECQ/CECC system provides following advantages to both supplier and customer:

- Approved relays are according to international standards. Therefore multiple sources for the same or similar products can be expected.
- For product qualification supervised Qualification Approval Test Reports are provided. Hence the cost for a product qualification can be reduced considerably, as none or a reduced number of tests have to be performed by the customer.
- The third party assessments are impartial, applying transparent procedures and are carried out by unbiased persons free from either the seller's or buyer's desires.
- Assessed quality relays are suitable for ship to line or ship to stock – no incoming inspection is necessary.
- Due to regular checks of all relay parameters, supervised by an independent organization, a high and steady quality level can be guaranteed.
- A continuous monitoring of the characteristic is ensured.

3. Quality level

The quality level is defined by the AOQL (Average Outgoing Quality Level).

AOQL = # of shipped relays / # of failed relays x 10^6

The AOQL is given in ppm (parts per million).

Usually the AOQL level only considers significant failures of the relay, which prevent the relay from performing its planned function such as not opening or not closing contacts, etc.

The quality is determined by:

- design to manufacturing process
- high precision individual parts
- stable production processes
- robust packaging and careful transportation

The quality level is measured by
- internal testing and product audits
- customer feedback

An AOQL of maximum 25 ppm can be expected on an existing product. AXICOM's target is to achieve zero defects.

ISO 9000 and IECQ/CECC

Evaluation of recorded Quality data

Process Qualification and Monitoring

Materials	Piece parts	Pre-Assembly	Relay Assembly	Final Assembly	Final Operations	Applied method
Material Specification Certification of conformity Supplier validation Supply agreement		-Contact quality - Coil resistance -Contact position	- Functional values - Synchronism - Contact force - Overtravel	-Sealing -Gas tightness -Coil resistance -Contact resistance -Functional values -Timing -Dielectric	-Co-planarity -Marking -Functional values	SPC In-process 100%
		-Dimensions			-Sealing -Dimensions -Solderabitity	SPC Sample
	-Dimensions -Visual	-Visual -Welding	- Visual - Welding	- Visual	-Visual -Packing	Sample

Process and Product Audits by Quality Assurance Team

Customer Quality Feedback

Maintenance and Calibration

Ongoing Training of all Staff

Fig. 35: Overview of the quality assurance system applied to the manufacturing of the new generation IM relay.

XIII. Glossary

Technical relay terms are used differently around the world. Depending on the relay application and the relay supplier, you will face a variety of terms. For this catalog, we prefer using technical terms according to IEC/EN 60 255 Part 1-00 as well as terms used in American English.

A

Adjacent contact
Electrically isolated contact sets of different poles.

Ambient temperature
Temperature in the direct environment of the relay.

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 produces high temperature locally causing contact erosion. In cases of strong erosion, arc suppression becomes necessary.

Caution: If the contact load exceeds the maximum switching power or the → 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

Bifurcated contact
Contact type with two contact studs per contact spring. Both contacts work in parallel, switch as far as possible at the time and are mechanically largely independent of each other. This ensures that contact reliability is considerably increased, preferred for the switching of smaller currents and voltages.

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
Also called NC contact. The break contact is closed in the release state of a non-latching relay and opens (breaks) when the armature moves to the core (operate state).

C

Capacitive load
Switching on a capacitive load results in high in-rush current. Depending on the contact material and contact dynamic, this current can be higher than the maximum switching voltage because the peak current is very short.

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.

Clearance distance
Shortest distance in air between two conductive elements.

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 for diodes in parallel to the coil. Further information is available on request.

Contact
The contact is made out of contact material and can consist of several different material layers. It is a 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 attached.

Contact configuration
Configuration of the relay switch (make, break or changeover contact). According to the application, various contact configurations are used (Tab. 10).
SP = Single Pole
DP = Double Pole
ST = Single Throw
DT = Double Throw
NO = Normally Open
NC = Normally Closed
Contacts which are moved by the armature system are called moveable contacts, and non-moving contacts are called stationary contacts.

Table listing the most important types of contact				
Designation	Abbreviations/Descriptions German	English	American	Circuit symbol
Make contact	1	A	SPST-NO	
Break contact	2	B	SPST-NC	
Changeover contact	21	C	SPDT	
Twin make contact	11	U	SPST-NO (DM)	
Twin break contact	2	Y	SPST-NC (DB)	
Bridging make contact	1	X	SPST-NO (Bridge)	

Tab. 10: Contact configurations

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

Contact force
Force between closed contact surfaces.

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

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 and stability
- 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 Fig. 36.
Contact materials especially suitable for telecom and signal loads are:

- Gold
- Silver, gold covered
- Silver-nickel, gold covered
- Silver-palladium, gold covered
- Palladium-ruthenium, gold covered
- Palladium-nickel, gold covered
- Ruthenium

As the load rating for a contact depends on the relay design (e.g. contact force and contact dynamic), the specification of one relay type cannot be simply transferred to another.

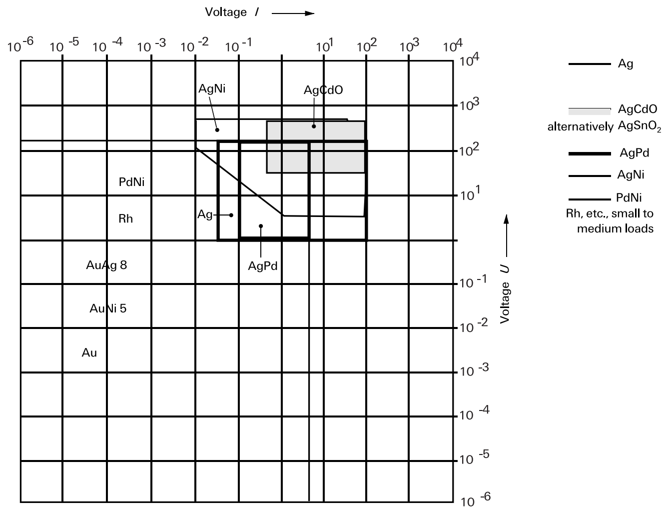


Fig. 36: Suitable loads for contact materials

Contact resistance (voltage drop)
This term is not literally correct because it implies more than the contact itself. What is meant is the electrical resistance between the relay load terminals while the respective contact is closed. The resistance can be obtained from the ratio of the voltage drop across the relay and the load current (Ohm's law). Due to slight contact corrosion, the contact voltage drop can be higher for small load currents. For loads in the ampere range, the heat generated by the current locally evaporates the surface layer (→ fritting), reducing the resistance.

Contact set
Comprises all contacts in a relay.

Creepage distance
Shortest distance on the surface of an insulating material between two conductive elements.

Cycle time
Sum of make and break (i. e.: on and off) time of a contact pair (Fig. 37).

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

t_{ED} = pulse width

t_z = cycle time

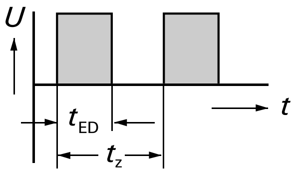


Fig. 37: Cycle time

D

Degree of protection
Ratings, for example as defined in IEC 60529, indicating how completely a cover, seal, etc. protects against water, humidity, dust, direct contact, etc.

Drop Test
Relays are dropped from a specified height onto a solid ground. This should simulate the resistance to bad handling, e.g. a fall from a table.

Dry switching
The relay contact switches no load or a very small electrical load (=10 mA, =30 mV).

Dustproof
Covered but non-sealed relay, featuring protection class IP 54 according to IEC 60529 or RT I according to IEC 61810-7 respectively.

Duty cycle
The ratio between the switch on time and total cycle time during periodical switching (Fig. 37). 50% duty cycle means the switch on time equals 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 catalog apply to resistive loads.

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

Energizing value, coil power
A current applied 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.

F

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 thin film on a contact surface. (R. Holm, Electric Contacts, 4th edition, 1967, Springer-Verlag, Berlin/Heidelberg/New York).

I

Immersion cleanable / sealed relay
Relays that are sealed against the penetration of specified PCB cleaners or lacquers. The protection class according IEC 60529 is IP 67 or RT III according to IEC 61810-7 respectively.

Inductive load
Inductive and AC loads reduce the expected lifetime depending on the power factor cos(j) (Fig. 38). The application of a suitable spark suppression can increase the reduction factor to nearly one.

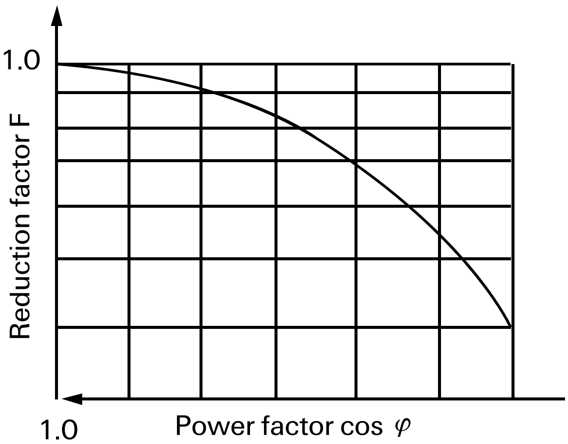


Fig. 38: Reduction of lifetime at inductive loads

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

K

K-factors
The K_I-factor is used to determine the minimum operate voltage U_I and the K_{II}-factor is used to determine the maximum voltage U_{II} for a certain ambient temperature.

AXICOM

L

Latching relay
In a latching relay, after the input voltage is disconnected, the contacts remain in the last switch position reached.

Limiting continuous current
Maximum permissible current carried by the relay contacts at maximum ambient temperatures. Exceeding this value usually leads to thermal damage.

Load limit curves
Switching limit for DC voltage and resistive loads (Fig. 39). The load limit curves usually are measured with low-inductive resistors. 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 curves are much more important for Automotive and General Purpose / Power Relays than for Telecom and Signal Relays.

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

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. The maximum switching power for Telecom and Signal Relays is always below low limit curve (I) for the specified load voltage and current range.

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). The curve applies to relays with only a make or a break contact.

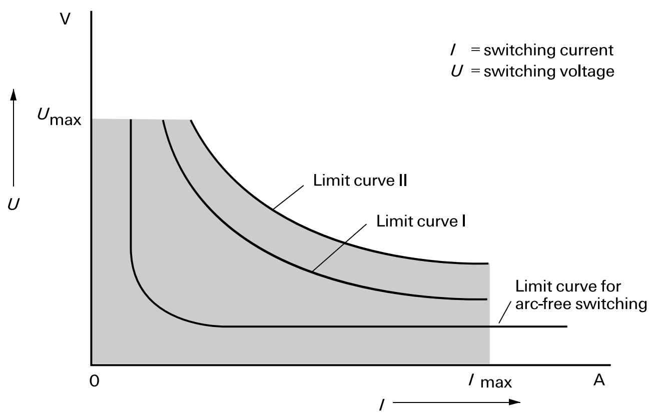


Fig. 39: Load limit curve

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.

M

Make contact, Form A
Also called NO contact. Contact is open in the release state of a non-latching relay and closes (makes) when the relay coil is energized (→ operate state).

Maximum coil temperature
The coil temperature depends on the ambient temperature, the power dissipation of the operated coil and the contact carrying current. It should not exceed the specified limit.

Maximum continuous (carrying) current
→ Limiting continuous current.

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 maximum permissible coil temperature.

Maximum permissible coil temperature.
Maximum coil temperature during operation that does not reduce the specified lifetime of the relay in a certain application.

Maximum switching current
Maximum permissible current switched by the relay contacts. Exceeding this value usually leads to electrical failures. See also electrical endurance and load limit curve.

Maximum switching power
Maximum permissible power switched by the relay contacts. Caution: This is not the product of maximum switching current and maximum switching voltage (→ load limit curve).

Maximum switching voltage
Maximum permissible voltage switched by the relay contacts. Exceeding this value usually leads to electrical failures. See also electrical endurance and load limit curve.

Maximum voltage U_{II}
Maximum coil voltage at 23°C, at which the coil reaches the specified maximum permissible temperature without contact load. Maximum operate voltages for the specified temperature range can be calculated by multiplication with the K_{II} factor.

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

Minimum operate voltage U_I (must operate voltage)
Voltage that a relay must operate at 23°C. Minimum operate voltages for the specified temperature range can be calculated by multiplication with the K_I factor.

Minimum release voltage (must release voltage)
Voltage that a non-latching relay must release at 23°C.

Monostable relay
Same as → non-latching relay.

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

N

NC contact
Same as break contact. The break contact is closed in the release state of a non-latching relay and opens (breaks) when the armature moves to the core (see operate state).

NO contact
Same as make contact. Contact is open in the release state of a non-latching relay and closes (makes) when the relay coil is energized (see operate state).

Nominal power consumption
Is defined with rated coil resistance and rated voltage respectively at 23°C.

Nominal values
See rated values.

Non-latching relay
Single side stable relay that returns to a defined release state after the coil is de-energized.

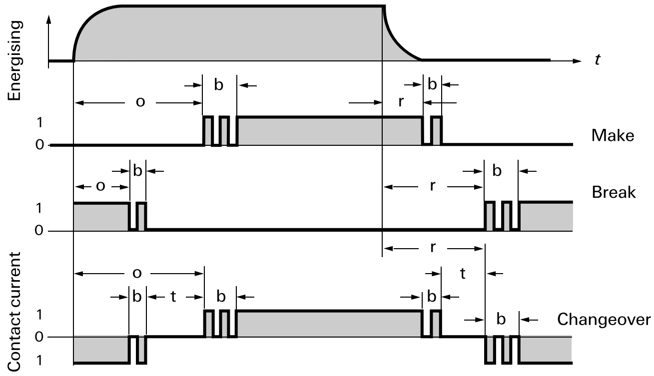
Non-operating current / voltage
Coil current / voltage at which an individual relay coil does not operate.

Non-polarized relay
The relay coil works independently of the polarity of the applied voltage.

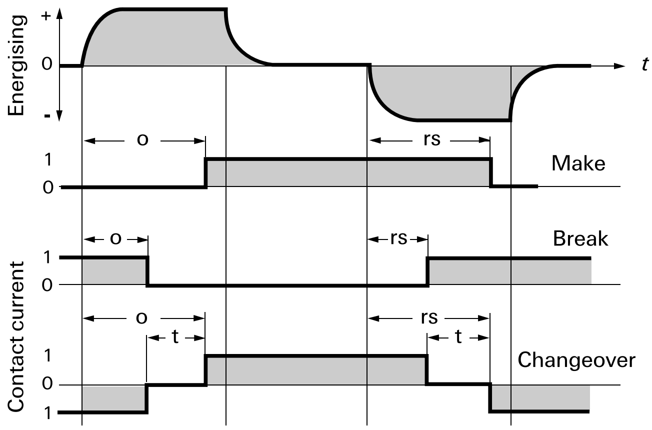
Non-release current / voltage
Coil current / voltage at which a monostable relay does not release.

O

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



o: operate time
r: release time
t: transit time
0: contact open
b: bounce time
rs: reset time
1: contact closed



Operate time
Time from energizing the relay coil till the first make of the NO contact. See relay time characteristics Fig. 40. The operate time is given as a typical value in each section of general data in this catalog. 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. 41.

Operate time

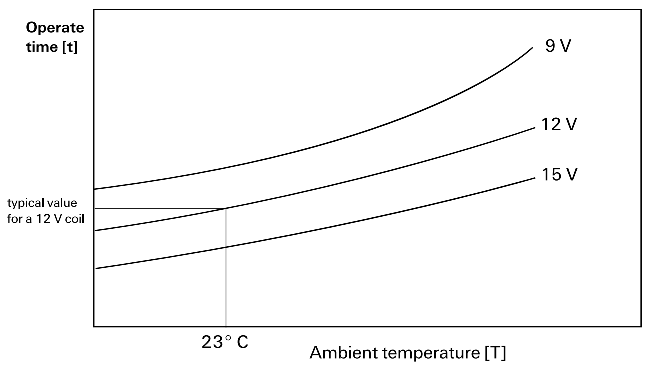


Fig. 41: Operate time depends on temperature and coil voltage

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

Polarized relay
The magnet system uses a permanent magnet to make the relay more sensitive. It also enables a latching function of the relay. The coil has to be energized with the correct polarity to switch the relay.

R

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

Relay protection classes for soldering processes
Protection classes are classified according to IEC 60529 for enclosures (IP code) or according to the relay specific IEC 61810-7 (RT code).

Class IP 54 or RT I: Non-sealed relays which are protected against flux by their base plate and cover (→ dustproof). Class IP 67 or RT III: describes sealed relays (→ immersion cleanable).

Relay time characteristics
Due to the inertia of a magnetic coil and the limited speed of the armature movement, various characteristic relay times can be defined as shown in Fig. 40.

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

Release current / voltage
Coil current / voltage at which a → non-latching relay releases.

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

Release time (drop time)
Time interval between de-energizing the coil of a → non-latching relay and the first make of the NC contact. The release time is given as a typical value in each section of general data in this catalog.

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

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

S

Sealed relay
Relays that are sealed against the penetration of specified PCB cleaners or lacquers. (→ dust protected or degree of protection; → relay protection classes for soldering processes and immersion cleanable)

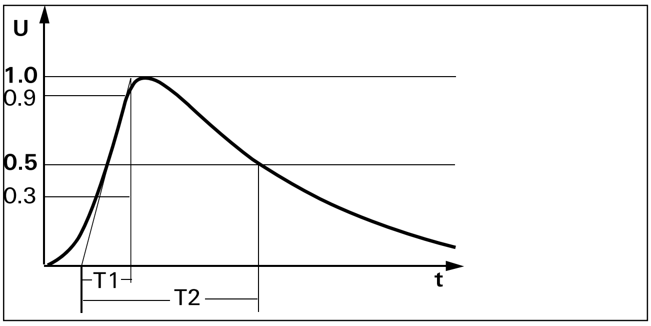
Shock resistance
The ability of a relay to operate properly during or after mechanical shock acceleration. The test procedure is described in IEC 60068-2-27.

Single contact
Contact configuration with single contact pieces (in opposition to → bifurcated contacts).

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

Stationary contact
Non-moveable contact, mounted on a contact carrier which is directly connected to a relay terminal.

Surge voltage resistance
Amplitude of a voltage impulse of short duration with a specified impulse form and polarity that is applied to test insulation paths in the relay, especially where relays are subjected to overvoltages caused by lightning. The shape of the pulse is defined by the height of the voltage and two time values. Thefirst value is the rise time to 0.9*Upeak and the second value is the decrease time to 0.5*Upeak, e.g. 2500 V (2 / 10 υs).



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 ambient room 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 give the amplitude of the switch off voltage approximately.

T

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

Thermal resistance
Relay parameter measured in Kelvin per Watt, which relates the consumed power with the respective temperature increase. 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.

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.

Transit time
The movement time of the armature during when both (NC and NO) contacts of a changeover relay are open (→ relay time characteristics, Fig. 40).

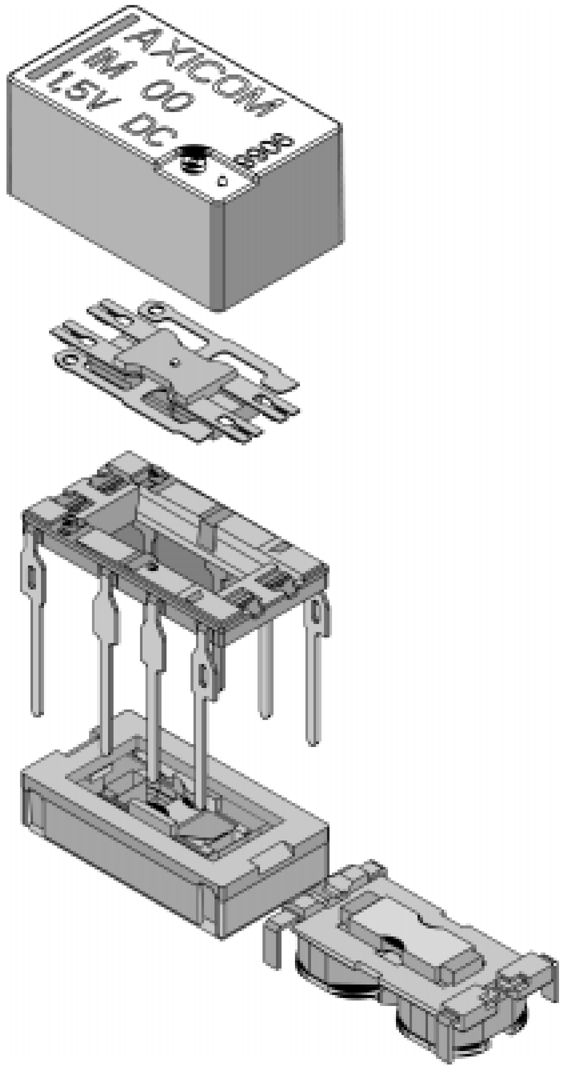
Twin contacts
See double contacts.

V

Vibration resistance
The ability of a relay to operate properly during a limited time of mechanical vibration.

Voltage drop
See contact resistance.

Slim line AND low profile
2 pole telecom/signal relay, polarized
Through Hole Types (THT), standard version
with 5.08 mm, narrow version with 3.2 mm between
the terminal rows
or
Surface Mount Type (SMT)



Relay types: non-latching with 1 coil
latching with 1 coil

Features

- Telecom/signal relay (dry circuit, test access, ringing)
- Slim line10 x 6 mm, 0.39 x 0.24 inch
- Low profile 5.65 mm, 0.222 inch
- Minimum board-space 60 mm^2
- Switching current 2 A
- 2 changeover contacts (2 form C / DPDT)
- Bifurcated contacts, gold plated
- High sensitivity results in low nominal power consumption
  140 mW for non latching
  100 mW for latching version
- High surge capability (1.2/50 µs and 10/700 µs) meets
  Bellcore GR 1089, FCC Part 68 and ITU-T K20
  ≥1500 V between open contacts
  ≥ 2500 V between coil and contacts
- High mechanical shock resistance
  up to 300 G functional
  up to 500 G survival

Typical applications:

- Communications equipment
  Linecard application – analog, ISDN, xDSL,
  PABX
  Voice over IP
- Office and business equipment
- Measurement and control equipment
- Consumer electronics
  Set top boxes, HiFi
- Medical equipment

Options:

Surge capability ≥ 2500 V between open contacts

Insulation category:

Supplementary insulation according IEC/EN 60950 and UL 1950

Working voltage	≤ 300 Vrms
Mains supply voltage	SMT: 250 Vrms
	THT: 200 Vrms
Repetitive peak voltage	2500 V
Pollution degree:	External: 2
	Internal: 1
Flammability classification:	V-0
Maximum operating temperature:	85°C

CSA-C22.2 No. 14-95 File No. 169679-1079886
CSA-C22.2 No. 950-95

UL 508 File No. E111441
UL 1950 3rd ed.

CECC 16501-003

QC 160501-CH0001

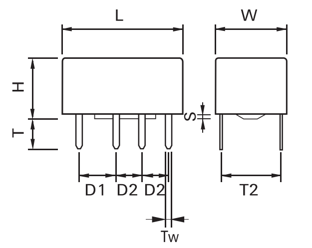
IEC/EN60950 IEC Ref. Cert. No. 1176

Dimensions

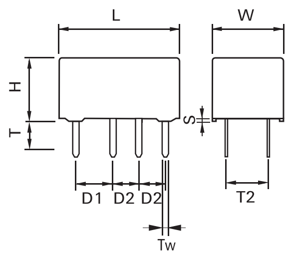
	IM THT Standard mm	IM THT Standard inch	IM THT Narrow mm	IM THT Narrow inch	IM SMT Gull Wings mm	IM SMT Gull Wings inch	IM SMT J-Legs	
L	10 ±0.08	0.393 ±0.003	10 ±0.08	0.393 ±0.003	10 ±0.08	0.393 ±0.003	10 ±0.08	0.393 ±0.003
W	6 ±0.08	0.236 ±0.003	5.7 ±0.3	0.224 ±0.012	6 ±0.08	0.236 ±0.003	6 ±0.08	0.236 ±0.003
H	5.65 -0.2	0.222 -0.008	5.85 -0.15	0.230 -0.006	5.65 -0.2	0.222 -0.008	5.65 -0.2	0.222 -0.008
T	3.2	0.125	3.2	0.125	N/A	N/A	N/A	N/A
T1	N/A	N/A	N/A	N/A	7.5 ±0.3	0.295 ±0.011	2.8 ±0.2	0.110 ±0.007
T2	5.08±0.1	0.200 ±0.004	3.2±0.1	0.126 ±0.006	5.08 ±0.1	0.200 ±0.004	5.08 ±0.1	0.200 ±0.004
D1	3.2 ±0.15	0.126 ±0.006	3.2 ±0.15	0.126 ±0.006	3.2 ±0.15	0.126 ±0.006	3.2 ±0.15	0.126 ±0.006
D2	2.2 ±0.15	0.087 ±0.006	2.2 ±0.15	0.087 ±0.006	2.2 ±0.15	0.087 ±0.006	2.2 ±0.15	0.087 ±0.006
Tw	0.4	0.015	0.4	0.015	0.4	0.015	0.4	0.015
S	0.3 ±0.05	0.011 ±0.002	0.3 ±0.05	0.011 ±0.002	N/A	N/A	N/A	N/A

THT Version

Standard version

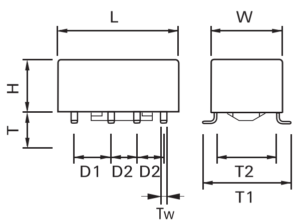


Narrow version

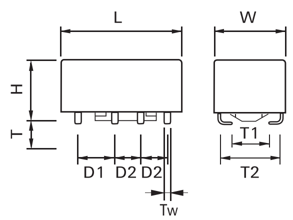


SMT Version

Gull Wings



J Legs

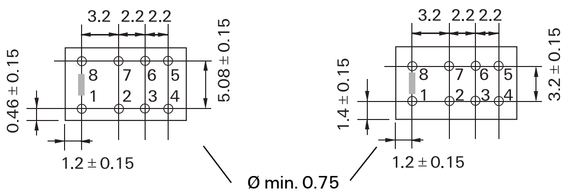


Mounting hole layout

View onto the component side of the PCB
(top view)

Standard version

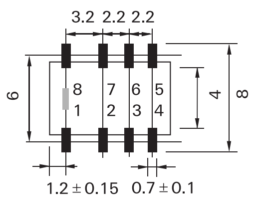
Narrow version



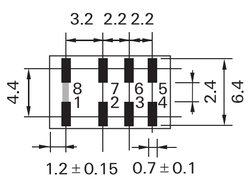
Solder pad layout

View onto the component side of the PCB
(top view)

Gull Wings



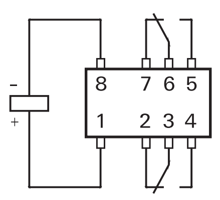
J Legs



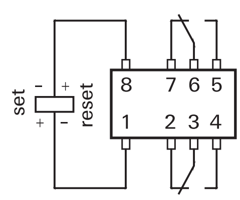
Terminal assignment

Relay - top view

Non-latching type,
not energized condition



Latching type, 1 coil
reset condition



Coil Data (values at 23°C)

Nominal voltage *U*nom	Operate/set voltage range Minimum voltage U_I	Maximum voltage U_{II}	Release/ reset voltage Minimum	Nominal power consumption	Resistance	Relay code
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	
non-latching 1 coil						
1.5	1.13	3.4	0.15	140	16	IM00
3	2.1	6.8	0.30	140	64	IM01
4.5	3.15	10.3	0.45	140	145	IM02
5	3.5	11.4	0.50	140	178	IM03
6	4.2	13.7	0.60	140	257	IM04
9	6.3	20.4	0.90	140	574	IM05
12	8.4	27.3	1.20	140	1028	IM06
24	16.8	45.6	2.40	200	2880	IM07
latching 1 coil						
1.5	1.13	4.1	- 1.13	100	23	IM40
3	2.25	8.1	- 2.25	100	90	IM41
4.5	3.38	12.1	- 3.38	100	203	IM42
5	3.75	13.5	- 3.75	100	250	IM43
6	4.5	16.2	- 4.50	100	360	IM44
9	6.75	24.2	- 6.75	100	810	IM45
12	9.00	32.3	- 9.00	100	1440	IM46
24	18.00	41.9	- 18.00	200	2880	IM47

Further coil versions are available on request.

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current

U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\,tamb}$ = $K_I \cdot U_{I\;23°C}$
and

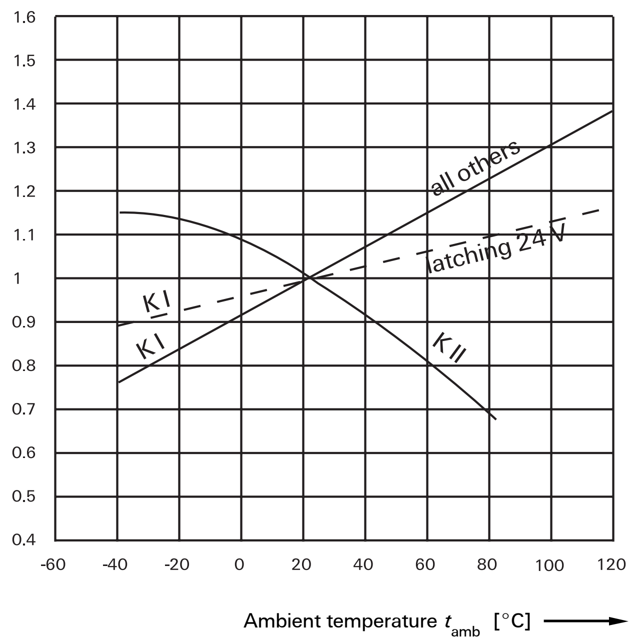
$U_{II\,tamb}$ = $K_{II} \cdot U_{II\;23°C}$

t_{amb} = Ambient temperature

$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}

$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}

k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Number of contacts and type		2 changeover contacts
Contact assembly		Bifurcated contacts
Contact material		Palladium-ruthenium, gold-covered
Limiting continuous current at max. ambient temperature		2 A
Maximum switching current		2 A
Maximum swichting voltage		220 Vdc 250 Vac
Maximum switching capacity		60 W, 62.5 VA
Thermoelectric potential		< 10 μV
Initial contact resistance / measuring condition: 10 mA / 20 mV		< 50 mΩ
Electrical endurance	at contact application 0	
	(≤ 30 mV / ≤ 10 mA)	min. 2.5 x 10^6 operations
	cable load open end	min. 2.0 x 10^6 operations
Resistive load	at 125Vdc / 0.24 A - 30 W	min. 5 x 10^5 operations
	at 220 Vdc / 0.27 A - 60 W	min. 1 x 10^5 operations
	at 250 Vac / 0.25 A - 62.5 VA	min. 1 x 10^5 operations
	at 30 Vdc / 1 A - 30 W	min. 5 x 10^5 operations
	at 30 Vdc / 2 A - 60 W	min. 1 x 10^5 operations
Mechanical endurance		typ. 10^8 operations
UL/CSA ratings		30 Vdc / 2 A 220 Vdc / 0.27 A 120 Vdc / 0.5 A 250 Vac / 0.25 A

Insulation

	Standard Version	High Dielectric Version
Insulation resistance at 500 VDC	> 10^9 Ω	> 10^9 Ω
Dielectric test voltage (1 min)		
between coil and contacts	1800 Vrms	1800 Vrms
between adjacent contact sets	1000 Vrms	1800 Vrms
between open contacts	1000 Vrms	1500 Vrms
Surge voltage resistance		
according to Bellcore TR-NWT-001089 (2 / 10 μs)		
between coil and contacts	2500 V	2500 V
between adjacent contact sets	1500 V	2500 V
between open contacts	1500 V	2500 V
according to FCC 68 (10 / 160 μs)		
between coil and contacts	2500 V	2500 V
between adjacent contact sets	1500 V	2500 V
between open contacts	1500 V	2500 V

High Frequency Data

Capacitance	
between coil and contacts	max. 2 pF
between adjacent contact sets	max. 2 pF
between open contacts	max. 1 pF
RF Characteristics	
Isolation at 100 / 900 MHz	- 37.0 dB / - 18.8 dB
Insertion loss at 100 / 900 MHz	- 0.03 dB / - 0.33 dB
V.S.W.R. at 100 / 900 MHz	1.06 / 1.49

* High Dielectric Version „C“

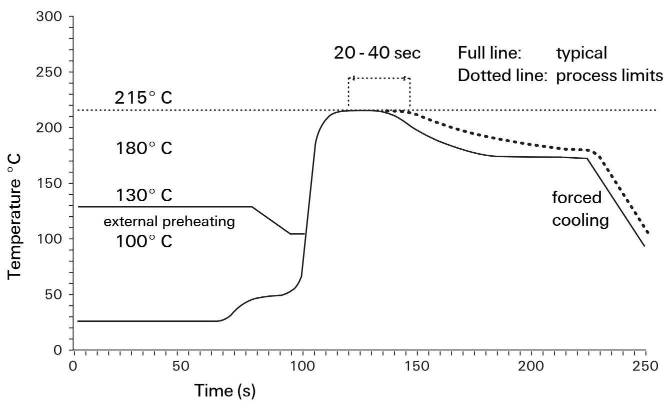
General data

Operate time at U_{nom} typ. / max.	1 ms / 3 ms
Reset time (latching) at U_{nom} , typ. / max.	1 ms /3 ms
Release time without diode in parallel (non-latching), typ. / max.	1 ms / 3 ms
Release time with diode in parallel (non-latching), typ. / max.	3 ms / 5 ms
Bounce time at closing contact, typ. / max.	1 ms / 5 ms
Maximum switching rate without load	50 operations/s
Ambient temperature	-40° C ... +85° C
Thermal resistance	< 150 K/W
Maximum permissible coil temperature	125° C
Vibration resistance (function)	20 G 10 to 1000 Hz
Shock resistance, half sinus, 11 ms half sinus, 0.5 ms	50 G (function) 500 G (damage)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 20 s, no burning and glowing
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 0.75 g
Resistance to soldering heat	260° C / 10 s

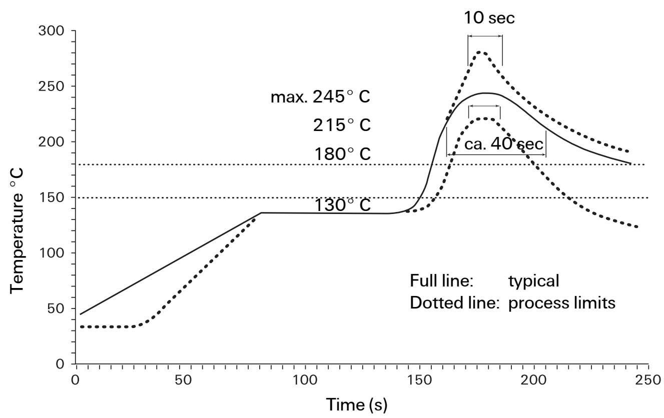
All data refers to 23° C unless otherwise specified.

Recommended soldering conditions

Soldering conditions according CECC 00802



Vapor Phase Soldering: Temperature/Time Profile
(Lead Temperature)

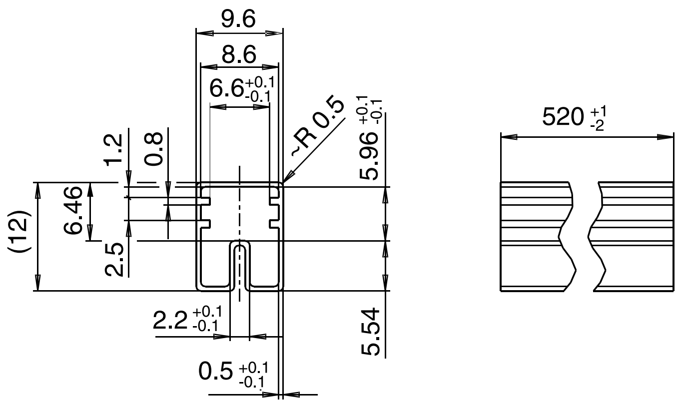


Infrared Soldering: Temperature/Time Profile
(Lead Temperature)

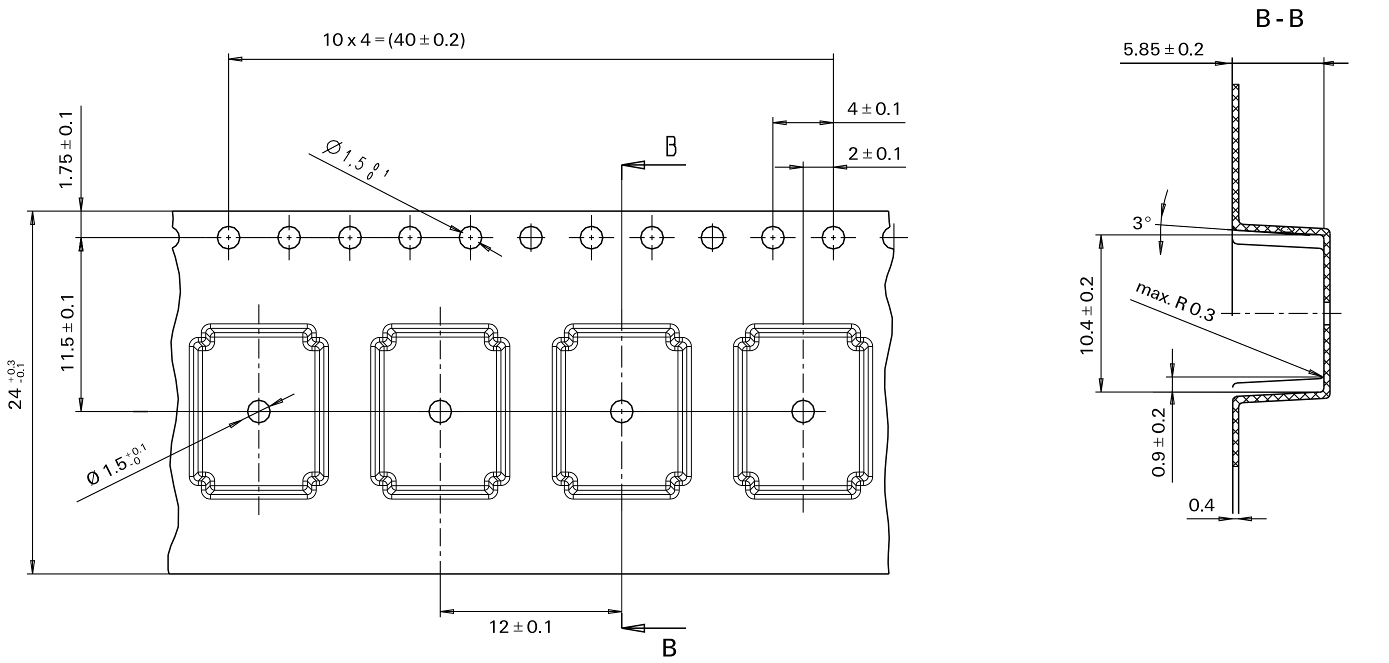
Packing

Dimensions in mm

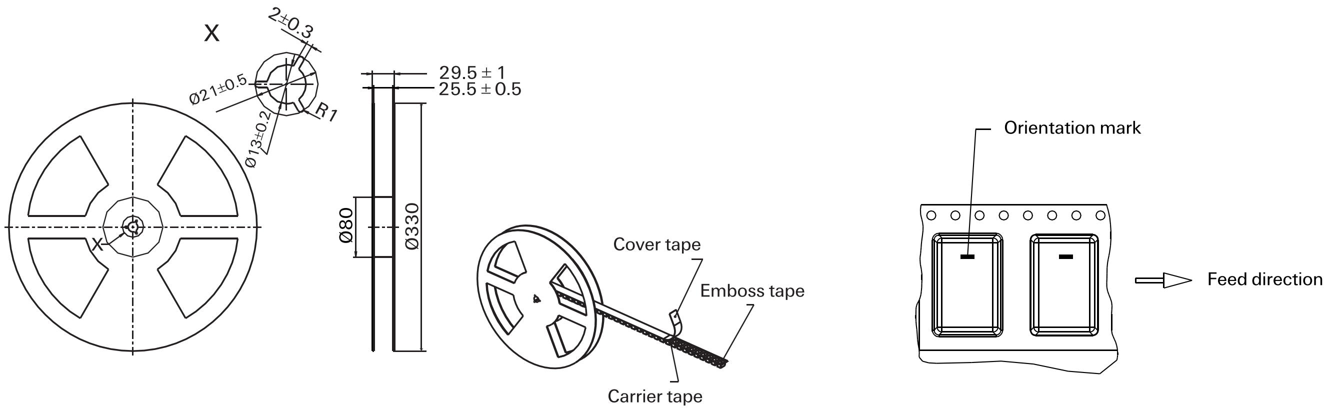
Tube for THT version - 50 relays per tube, 1000 relays per box



Tape and reel for SMT version - 1´000 relays / reel, 1´000 or 5´000 relays / box



Reel dimension



Ordering Information

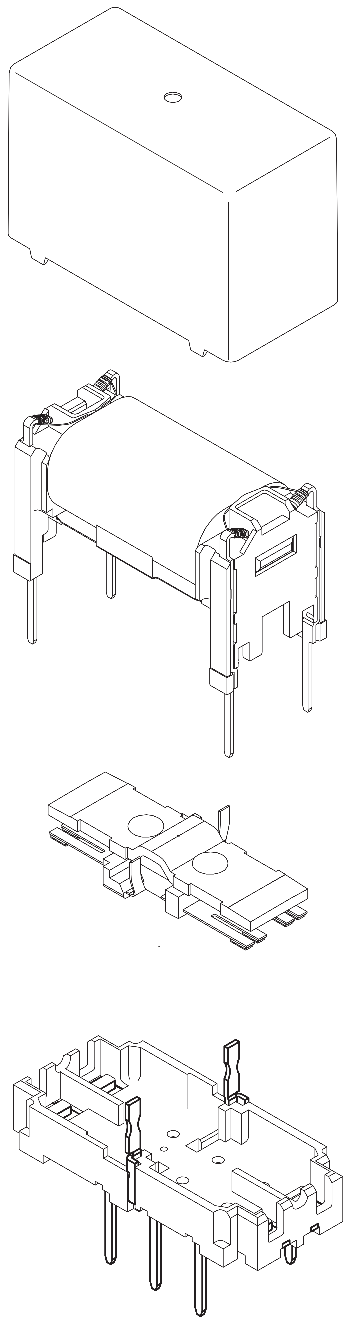
Relay Code	Tyco Part Number	Relay Code	Tyco Part Number
IM00GR	3-1462037-7	IM07TS	3-1462037-0
IM00JR	3-1462037-9	IM07NS	1-1462038-7
IM00TS	3-1462037-5	IM40GR	5-1462037-1
IM00NS	1-1462038-0	IM40JR	5-1462037-2
IM01GR	0-1462037-1	IM40TS	5-1462037-0
IM01CGR	0-1462038-4	IM40NS	1-1462038-8
IM01JR	4-1462037-0	IM41GR	5-1462037-4
IM01TS	0-1462037-4	IM41JR	5-1462037-5
IM01NS	1-1462038-1	IM41TS	5-1462037-3
IM02GR	0-1462037-9	IM41NS	1-1462038-9
IM02CGR	0-1462038-1	IM42GR	3-1462037-1
IM02JR	1-1462037-1	IM42JR	5-1462037-7
IM02TS	1-1462037-3	IM42TS	5-1462037-6
IM02NS	1-1462038-2	IM42NS	2-1462038-0
IM03GR	1-1462037-4	IM43GR	5-1462037-9
IM03CGR	0-1462038-2	IM43JR	6-1462037-0
IM03JR	1-1462037-6	IM43TS	5-1462037-8
IM03TS	1-1462037-8	IM43NS	2-1462038-1
IM03NS	1-1462038-3	IM44GR	6-1462037-2
IM04GR	4-1462037-2	IM44JR	6-1462037-3
IM04JR	4-1462037-4	IM44TS	6-1462037-1
IM04TS	4-1462037-1	IM44NS	2-1462038-2
IM04NS	1-1462038-4	IM45GR	6-1462037-4
IM05GR	3-1462037-4	IM45JR	6-1462037-5
IM05CGR	0-1462038-3	IM45TS	3-1462037-2
IM05JR	4-1462037-5	IM45NS	2-1462038-3
IM05TS	2-1462037-2	IM46GR	6-1462037-7
IM05NS	1-1462038-5	IM46JR	6-1462037-8
IM06GR	2-1462037-3	IM46TS	6-1462037-6
IM06CGR	9-1462037-9	IM46NS	2-1462038-4
IM06JR	4-1462037-6	IM47GR	7-1462037-0
IM06TS	2-1462037-7	IM47JR	7-1462037-1
IM06NS	1-1462038-6	IM47TS	6-1462037-9
IM07GR	4-1462037-7	IM47NS	2-1462038-5
IM07JR	4-1462037-8		

IM ␣␣␣␣

- Packaging:
  - S Tube
  - R Reel
- Terminal shape:
  - T = THT - Standard
  - N = THT - Narrow
  - J = SMT J-Legs
  - G = SMT Gull Wing
- Dielectric type:
  - Nil = Standard Type
  - C = High Dielectric Version
- Coil Version: see coil data on page 4

2 pole telecom relay, polarized,
Through Hole Type (THT) or
Surface Mount Technology (SMT),

Relay types: non-latching with 1 coil
latching with 2 coils
latching with 1 coil



Features

- Standard telecom relay (ringing and test access)
- Slim line 15 x 7.5 mm, 0.590 x 0.295 inch
- Switching current 5 A
- 2 changeover contacts (2 form C / DPDT)
- Bifurcated contacts
- Immersion cleanable
- High sensitivity results in low nominal power consumption
  140 mW for non-latching and latching with 2 coils
  70 mW for latching with 1 coil
- For single coil version:
  - Surge voltage resistance between contact and coil for single coil version:
  - 2.5 kV (2 / 10 μsec) meets the Bellcore Requirement GR-1089
  - 1.5 kV (10 / 160 μsec) meets FCC Part 68

Typical applications

- Communications equipment
  linecard application (ringing and test access)
  PABX
  Voice over IP
- Office equipment
- Measurement and control equipment
- Automotive equipment
  CAN bus, keyless entry, speaker switch
- Medical equipment
- Consumer electronics
  Set Top Boxes, HiFi

Options

- 1500 Vrms between open contacts
- Temperature range up to 105° C

LR 45064-23

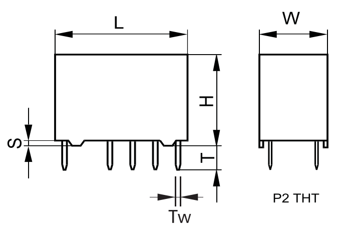
E 48393

Basic insulation coil/contacts according to IEC/EN 60950
Clearance > 1 mm
Creepage distance > 2.5 mm

Dimensions

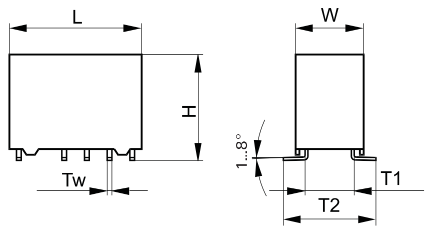
	THT V23079-x1xxx-B301 standard coil		THT V23079-x2xxx-B301 overmolded coil		SMT long terminals V23079-x1xxx-B301 standard coil		SMT long terminals V23079-x2xxx-B301 overmolded coil		SMT short terminals V23079-x1xxx-B301 standard coil		SMT short terminals V23079-x2xxx-B301 overmolded coil	
	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
L	14.5 ± 0.1	0.570 ± 0.004	14.5 ± 0.1	0.570 ± 0.004	14.5 ± 0.1	0.570 ± 0.004	14.5 ± 0.1	0.570 ± 0.004	14.5 ± 0.1	0.570 ± 0.004	14.5 ± 0.1	0.570 ± 0.004
W	7.2 ± 0.1	0.283 ± 0.004	7.2 ± 0.1	0.283 ± 0.004	7.2 -0.15	0.283 ± 0.004	7.2 -0.15	0.283 ± 0.004	7.2 -0.15	0.283 ± 0.004	7.2 -0.15	0.283 ± 0.004
H	9.8 ± 0.1	0.385 ± 0.004	9.5 ± 0.1	0.374 ± 0.004	10.4 ± 0.15	0.409 ±0.006	9.9 ± 0.1	0.390 ± 0.004	10.4 ± 0.15	0.409 ±0.006	9.9 ± 0.1	0.390 ± 0.004
T	3.25 - 0.25	0.128 -0.010	3.25 - 0.25	0.128 -0.010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
T1	N/A	N/A	N/A	N/A	5.52 ±0.15	0.217 ±0.006	5.52	0.217 ±0.006	5.52	0.217 ±0.006	5.52	0.217 ±0.006
T2	N/A	N/A	N/A	N/A	9.4 ±0.15	0.370 ±0.006	9.4 ±0.15	0.370 ±0.006	7.4 ±0.15	0.291 ±0.006	7.4 ±0.15	0.291 ±0.006
Tw	0.5 ± 0.05	0.020 ±0.002	0.5 ± 0.05	0.020 ±0.002	0.5 ± 0.05	0.020 ±0.002	0.5 ± 0.05	0.020 ±0.002	0.5 ± 0.05	0.020 ±0.002	0.5 ± 0.05	0.020 ±0.002
S	0.55 - 0.15	0.022 -0.006	0.45	0.018 ±0.002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

THT Version

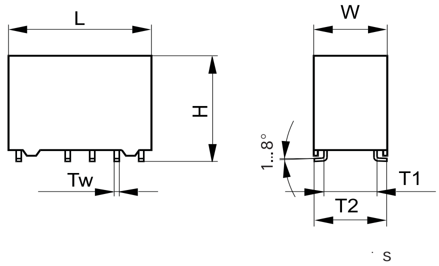


SMT Version

Long terminals

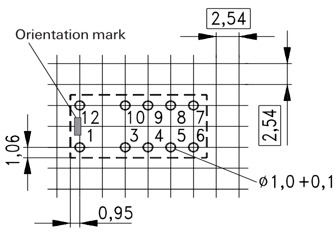


Short terminals



Mounting hole layout

View onto the component side of the PCB

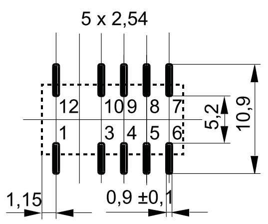


Note: Hole for pin 6 and 7
only for latching with 2 coils
Basic grid 2.54 mm

Solder pad layout

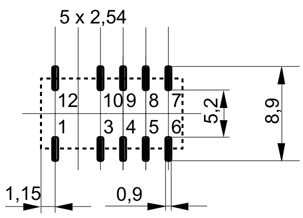
View onto the component side of the PCB

Long terminals



Note: Solder pad for pin 6 and 7
only for latching with 2 coils

Short terminals

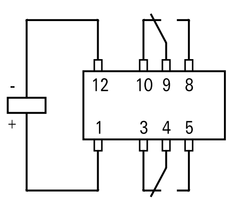


Note: Solder pad for pin 6 and 7
only for latching with 2 coils

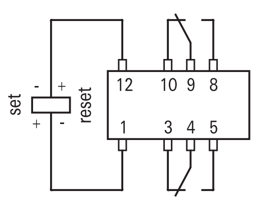
Terminal assignment

Relay - top view

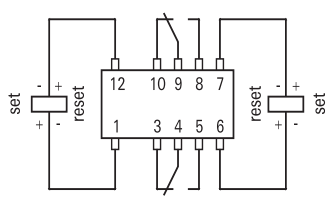
Non-latching type,
not energized condition



Latching type, 1 coil
reset condition



Latching type, 2coils
reset condition



Coil Data (values at 23°C)

Nominal voltage Unom	Operate/set voltage range		Release/ reset voltage Minimum	Nominal power consumption	Resistance	Coil number
	Minimum voltage U_I	Maximum voltage U_{II}				
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	

non-latching
1 coil

A1xxx/D1xxx/G1xxx
A2xxx/D2xxx/G2xxx

3	2.25	6.50	0.30	140	64.3	008
4	3.00	8.70	0.40	140	114	016
4.5	3.375	9.80	0.45	140	145	011
5	3.75	10.90	0.50	140	178	001
6	4.5	13.00	0.60	140	257	002
9	6.75	19.60	0.90	140	578	006
12	9.00	26.15	1.20	140	1029	003
24*	18.00	52.30	2.40	140	4114	005

latching
2 coils

B1xxx/E1xxx/H1xxx

3	2.25	6.50	2.25	140	64.3	208
4.5	3.375	9.80	3.375	140	145	211
5	3.75	10.90	3.75	140	178	201
6	4.5	13.00	4.50	140	257	202
9	6.75	19.60	6.75	140	578	206
12	9.00	26.15	9.00	140	1029	203
24	18.00	52.30	18.00	140	4114	205

latching
1 coil

C1xxx/F1xxx/J1xxx

3	2.25	9.20	2.25	70	128	108
4.5	3.375	13.85	3.375	70	289	111
5	3.75	15.33	3.75	70	357	101
6	4.5	18.50	4.50	70	514	102
9	6.75	27.75	6.75	70	1157	106
12	9.00	37.00	9.00	70	2057	103
24	18.00	74.00	18.00	70	8228	105

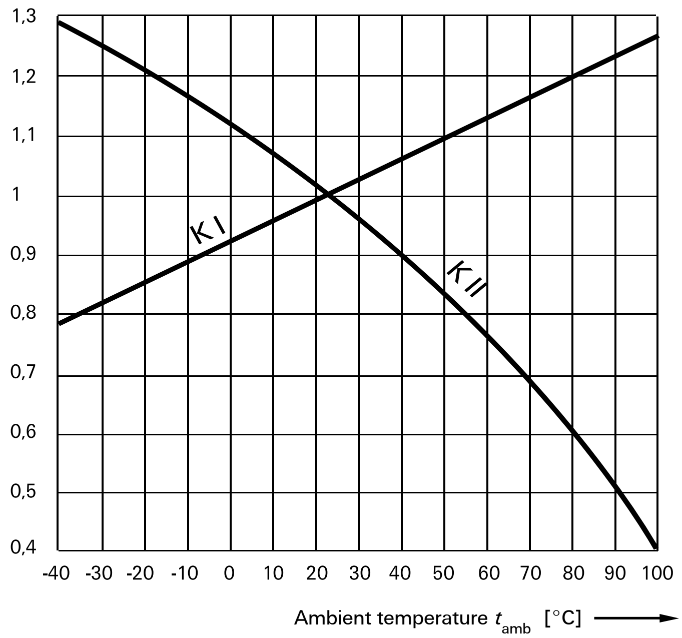
* 24 V only in A1xxx/D1xxx/G1xxx
Further coil versions are available on request.

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current
U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\,tamb} = K_I \cdot U_{I\,23°C}$
and
$U_{II\,tamb} = K_{II} \cdot U_{II\,23°C}$

t_{amb} = Ambient temperature
$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}
$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}
k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Number of contacts and type	2 changeover contacts
Contact assembly	Bifurcated contacts
Contact material	Silver nickel, gold-covered
Limiting continuous current at max. ambient temperature	2 A
Maximum switching current	5 A
Maximum swichting voltage	220 Vdc 250 Vac
Maximum switching capacity	60 W, 62.5 VA
Thermoelectric potential	< 10 μV
Initial contact resistance / measuring condition: 10 mA / 20 mV	< 50 mΩ
Electrical endurance at 12 V / 10 mA	typ. 5 x 10^7 operations
at 6 V / 100 mA	typ. 1 x 10^7 operations
at 60 V / 500 mA	typ. 5 x 10^5 operations
at 30 V / 1000 mA	typ. 1 x 10^6 operations
at 30 V / 2000 mA	typ. 2 x 10^5 operations
Mechanical endurance	typ. 10^8 operations
UL/CSA ratings	30 Vdc / 1 A 110 Vdc / 0.3 A 120 Vac / 0.5 A 240 Vac / 0.25 A

Insulation

Insulation resistance at 500 VDC	> 10^9 Ω
Dielectric test voltage (1 min)	
between coil and contacts (Relay with 1 coil)	1500 Vrms
between adjacent contact sets	1000 Vrms
between open contacts	1000 Vrms (1500 Vrms on request)
Surge voltage resistance	
according to Bellcore TR-NWT-001089 (2 / 10 μs)	
between coil and contacts (Relay with 1 coil)	2500 V
between adjacent contact sets	2500 V
between open contacts	2000 V
according to FCC 68 (10 / 160 μs)	
between coil and contacts (Relay with 1 coil)	1500 V
between adjacent contact sets	1500 V
between open contacts	1500 V

High Frequency Data

Capacitance	
between coil and contacts	max. 2 pF
between adjacent contact sets	max. 1.5 pF
between open contacts	max. 1 pF
RF Characteristics	
Isolation at 100 / 900 MHz	- 39.0 dB / - 20.7 dB
Insertion loss at 100 / 900 MHz	- 0.02 dB / - 0.27 dB
V.S.W.R. at 100 / 900 MHz	1.04 / 1.40

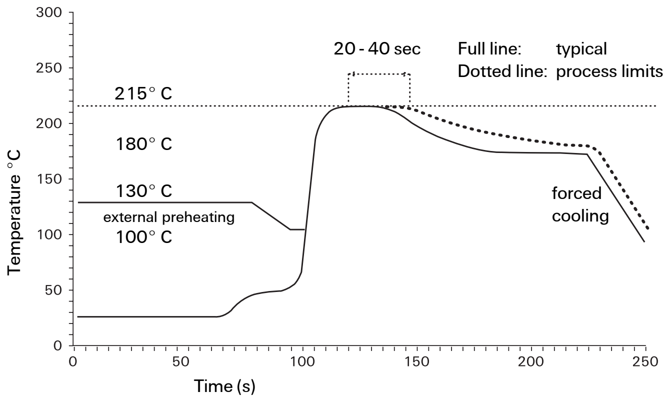
General data

Operate time at U_{nom} typ. / max.	3 ms / 5 ms
Reset time (latching) at U_{nom}, typ. / max.	3 ms / 5 ms
Release time without diode in parallel (non-latching), typ. / max.	2 ms / 4 ms
Release time with diode in parallel (non-latching), typ. / max.	4 ms / 6 ms
Bounce time at closing contact, typ. / max.	1 ms / 3 ms
Maximum switching rate without load	50 operations/s
Ambient temperature	-40° C ... +85° C (105 ° C on request)
Thermal resistance	< 165 K/W
Maximum permissible coil temperature	110° C
Vibration resistance (function)	35 G 10 to 1000 Hz
Shock resistance, half sinus, 11 ms	50 G (function) 150 G (damage)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 20 s, burning time < 15 s
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 2.5 g
Resistance to soldering heat	260° C / 10 s

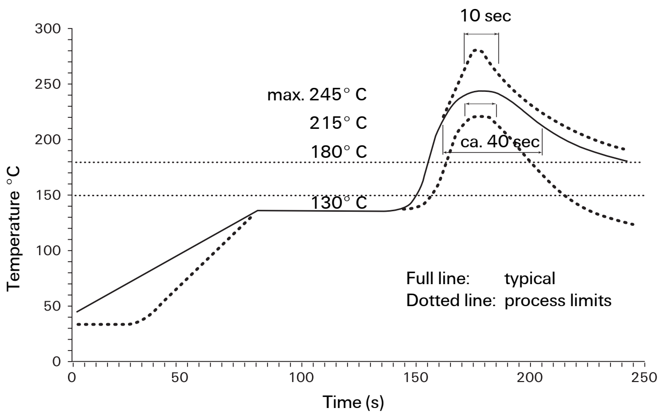
All data refers to 23° C unless otherwise specified.

Recommended soldering conditions

Soldering conditions according CECC 00802



Vapor Phase Soldering: Temperature/Time Profile
(Lead Temperature)

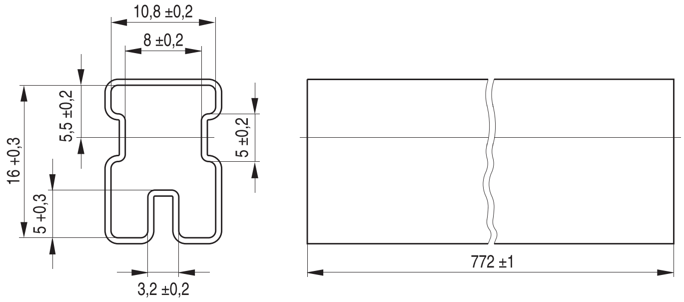


Infrared Soldering: Temperature/Time Profile
(Lead Temperature)

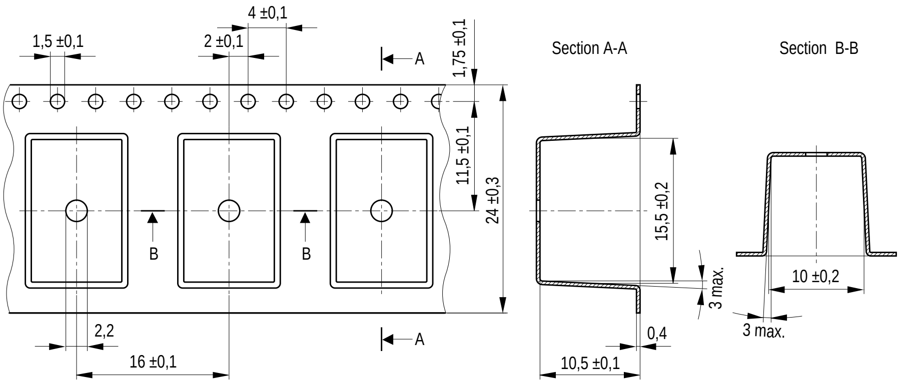
Packing

Dimensions in mm

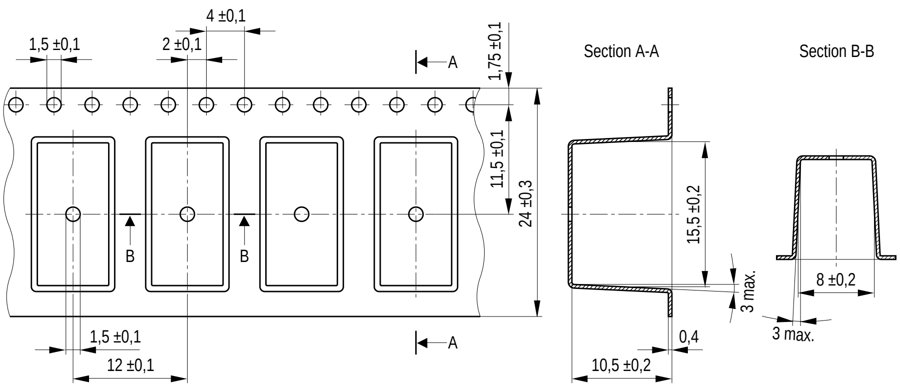
Tube for THT version - 50 relays per tube, 2000 relays per box



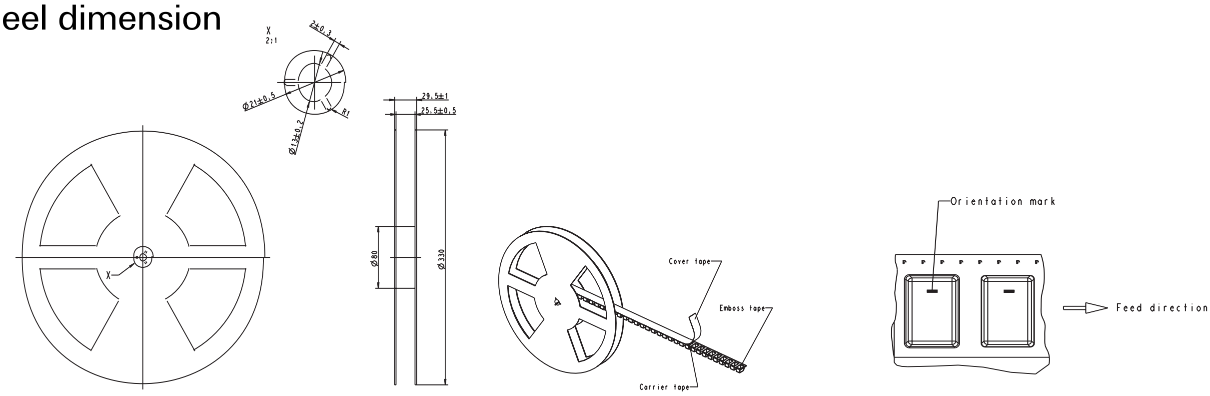
Tape and reel for SMT version with long terminals - 400 relays per reel, 2000 relays per box



Tape and reel for SMT version with short terminals - 500 relays per reel, 2500 relays per box



Reel dimension



Ordering Information

Relay Code	Tyco Part Number	Relay Code	Tyco Part Number
V23079-A1001-B301	0-1393788-3	V23079-E1201-B301	6-1393788-8
V23079-A1002-B301	0-1393788-8	V23079-E1202-B301	0-1393789-5
V23079-A1003-B301	1-1393788-1	V23079-E1203-B301	6-1393788-9
V23079-A1005-B301	1-1393788-6	V23079-E1205-B301	7-1393788-0
V23079-A1006-B301	2-1393788-0	V23079-E1206-B301	0-1393789-9
V23079-A1008-B301	2-1393788-2	V23079-E1208-B301	7-1393788-1
V23079-A1011-B301	2-1393788-4	V23079-E1211-B301	7-1393788-2
V23079-A2001-B301	3-1393789-5	V23079-F1101-B301	7-1393788-3
V23079-A2002-B301	3-1393789-6	V23079-F1102-B301	1-1393789-0
V23079-A2003-B301	3-1393789-7	V23079-F1103-B301	7-1393788-4
V23079-A2005-B301	0-1393790-2	V23079-F1105-B301	1-1393789-1
V23079-A2006-B301	3-1393789-8	V23079-F1106-B301	1-1393789-2
V23079-A2008-B301	6-1419120-6	V23079-F1108-B301	7-1393788-5
V23079-A2011-B301	3-1393789-9	V23079-F1111-B301	1-1393789-4
V23079-B1201-B301	3-1393788-3	V23079-G1001-B301	7-1393788-6
V23079-B1202-B301	3-1393788-5	V23079-G1002-B301	1-1393789-5
V23079-B1203-B301	3-1393788-6	V23079-G1003-B301	7-1393788-7
V23079-B1205-B301	3-1393788-7	V23079-G1005-B301	7-1393788-8
V23079-B1206-B301	3-1393788-9	V23079-G1006-B301	1-1393789-6
V23079-B1208-B301	4-1393788-1	V23079-G1008-B301	8-1393788-0
V23079-B1211-B301	4-1393788-2	V23079-G1011-B301	1-1393789-7
V23079-C1101-B301	4-1393788-5	V23079-G2001-B301	4-1393789-9
V23079-C1102-B301	4-1393788-7	V23079-G2002-B301	5-1393789-0
V23079-C1103-B301	4-1393788-8	V23079-G2003-B301	5-1393789-1
V23079-C1105-B301	5-1393788-0	V23079-G2006-B301	5-1393789-3
V23079-C1106-B301	5-1393788-1	V23079-G2008-B301	5-1393789-4
V23079-C1108-B301	5-1393788-3	V23079-G2011-B301	5-1393789-5
V23079-C1111-B301	5-1393788-4		
V23079-D1001-B301	5-1393788-5	V23079-H1201-B301	2-1393789-0
V23079-D1002-B301	5-1393788-6	V23079-H1202-B301	2-1393789-1
V23079-D1003-B301	5-1393788-7	V23079-H1203-B301	8-1393788-3
V23079-D1005-B301	5-1393788-8	V23079-H1205-B301	2-1393789-2
V23079-D1006-B301	5-1393788-9	V23079-H1206-B301	2-1393789-3
V23079-D1008-B301	6-1393788-1	V23079-H1208-B301	2-1393789-4
V23079-D1011-B301	6-1393788-2	V23079-H1211-B301	8-1393788-4
V23079-D2001-B301	4-1393789-3	V23079-J1101-B301	2-1393789-5
V23079-D2002-B301	4-1393789-4	V23079-J1102-B301	2-1393789-6
V23079-D2003-B301	4-1393789-5	V23079-J1103-B301	2-1393789-7
V23079-D2006-B301	4-1393789-6	V23079-J1105-B301	2-1393789-8
V23079-D2008-B301	4-1393789-7	V23079-J1108-B301	2-1393789-9
V23079-D2011-B301	4-1393789-8	V23079-J1111-B301	3-1393789-0

Middle block of relay code

V23079-yyxxx-B301
yy : See table below
xxx : See coil table on page 4

yy	Description
A1	THT, non latching, standard coil
A2	THT, non latching, overmolded coil
B1	THT, latching, 2 standard coils
C1	THT, latching, 1 standard coil
D1	SMT, long pins, non latching, standard coil
D2	SMT, long pins, non latching, overmolded coil
E1	SMT, long pins, latching, 2 standard coils
F1	SMT, long pins, latching, 1 standard coil
G1	SMT, short pins, non latching, standard coil
G2	SMT, short pins, non latching, overmolded coil
H1	SMT, short pins, latching, 2 standard coils
J1	SMT, short pins, latching, 1 standard coil

Option: high dielectric between open contacts

This supplementary data sheet refers to the basic data sheet of the P2 relay series (V23079) with following additions:

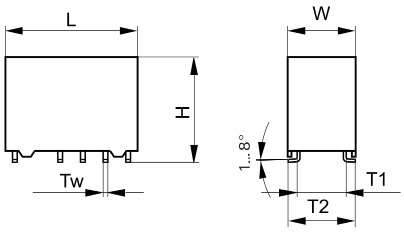
- Dielectric strength 1500 V_{rms} and surge voltage 2500 V (2/10 µs) between open contacts - as well as between coil and contacts and between adjacent contact sets
- No latching types and no overmolded coil types available
- SMT version with short terminals as preferred type
- 280 mW nominal coil power
- mechanical and electrical endurance typ. 10^5 operations

Dimensions

	SMT short terminals V23079-G1xxx-B301 standard coil	
	mm	inch
L	14.5 ± 0.1	0.570 ± 0.004
W	7.2 -0.15	0.283 ± 0.004
H	10.4 ± 0.15	0.409 ±0.006
T1	5.52	0.217 ±0.006
T2	7.4 ±0.15	0.291 ±0.006
Tw	0.5 ± 0.05	0.020 ±0.002

SMT Version

Short terminals



Coil Data (values at 23°C)

Nominal voltage *U*nom	Operate/set voltage range Minimum voltage U_I	Maximum voltage U_{II}	Release/ reset voltage Minimum	Nominal power consumption	Resistance	Relay code
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %Ω / ± 10 %	
non-latching 1 coil						V23079-
3	2.25	5.0	0.30	280	32.1	G1038-X069
5	3.75	8.3	0.50	280	89.3	G1031-X070
12	9.00	20.0	1.20	280	514.3	G1033-X045
24	18.00	40.0	2.40	280	2057	G1035-X067

Ordering Information

Relay Code	Tyco Part Number
V23079-G1031-X070	0-1422005-4
V23079-G1033-X045	0-1422005-2
V23079-G1035-X067	0-1422005-1
V23079-G1038-X069	0-1422005-3

2 pole telecom / signal relay
Through Hole Type (THT)
Polarized, latching or non-latching 1 coil

Versions

– Relay types: sensitive non lachting version with 1 coil
high sensitive non latching version with 1 coil
latching with 1 coil

Features

– Telecom / signal relay (dry circuit, test access, ringing)
– Slim line 15 x 7.3 mm, 0.590 x 0.287 inch
– Switching current 2 A
– 2 changeover contacts (2 form C / DPDT)
– Bifurcated contacts
– High sensitivity results in low nominal power consumption
80 mW for high sensitive, 140 mW for sensitive version
– High dielectric characteristic
≥ 1800 Vrms also between open contact
– High surge capability (1.2 / 50 µs and 10 / 700 µs) meets Bellcore GR 1089 and FCC Part 68
≥ 2500 V between open contacts
≥ 3500 V between coil and contacts
– High mechanical shock
up to 300 G functional
up to 1500 G survival

Typical applications

– Communications equipment
linecard application - analog, ISDN, xDSL, PABX
Voice over IP
– Office and business equipment
– Measurement and control equipment
– Consumer electronics
Set top boxes, HiFi
– Medical equipment

CSA-C22.2 No. 14-95 File No. 176679-1079886
CSA-C22.2 No. 950-95

UL 508 File No. E111441

CECC 16504-002

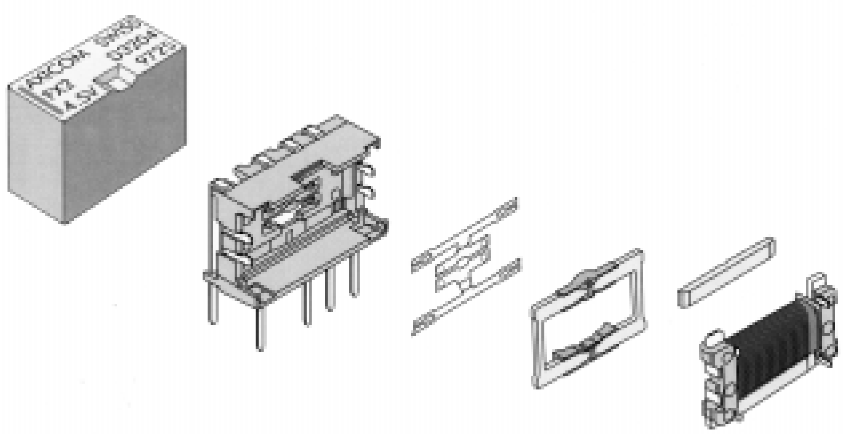
QC 160504-CH0002

IEC/EN60950 IEC Ref. Cert. No. 1072

Insulation category:

Supplementary insulation according IEC / EN 60950 and UL 1950

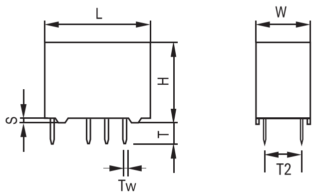
Working voltage	≥ 300 Vrms	
Mains supply voltage	≥ 250 Vrms	
Repetitive peak voltage	2500 V	
Pollution degree:	Internal:	1
	External:	2
Flammability classification:	V-0	
Maximum operating temperature:	85 °C	



Dimensions

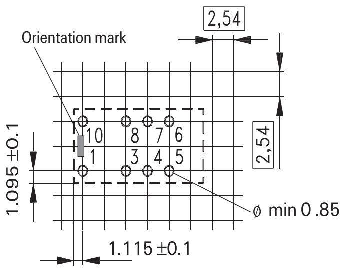
	THT mm	THT inch
L	14.93 ± 0.08	0.587 ± 0.003
W	7.27 ± 0.08	0.283 ± 0.003
H	10.7 ± 0.08	0.421 ± 0.003
T	3.3 ± 0.3	0.129 ± 0.011
T1	N/A	N/A
T2	5.08 ± 0.1	0.200 ± 0.004
Tw	0.5	0.020
S	0.3 ± 0.05	0.011 ± 0.002

THT Version



Mounting hole layout

View onto the component side of the PCB
(top view)

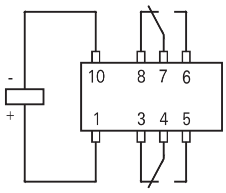


Basic grid 2.54 mm

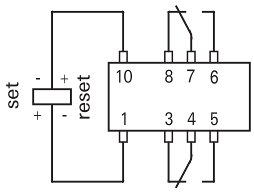
Terminal assignment

Relay - top view

Non-latching type,
not energized condition



Latching type, 1 coil
reset condition



Coil Data (values at 23°C)

Nominal voltage Unom	Operate/set voltage range Minimum voltage U_I	Operate/set voltage range Maximum voltage U_{II}	Release/ reset voltage Minimum	Nominal power consumption	Resistance	Relay Code
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	

non-latching
1 coil

3	2.1	6.8	0.30	140	64	D 3206
4	2.8	7.6	0.40	140	114	D 3207
4.5	3.15	10.3	0.45	140	145	D 3204
5	3.5	11.4	0.50	140	178	D 3209
6	4.2	13.7	0.60	140	257	D 3205
9	6.3	20.4	0.90	140	574	D 3210
12	8.4	27.3	1.20	140	1028	D 3202
24	16.8	45.7	2.40	200	2880	D 3212
48	33.6	67.5	4.80	300	7680	D 3213

non-latching 1 coil
high sensitive version

3	2.25	9.0	0.3	80	113	D 3221
4.5	3.38	13.5	0.45	80	253	D 3222
5	3.75	15.0	0.5	80	313	D 3223
6	4.5	18.0	0.6	80	450	D 3224
9	6.75	27.1	0.9	80	1013	D 3225
12	9.00	36.1	1.2	80	1800	D 3226
24	18.00	54.7	2.4	140	4114	D 3227
48	36.00	72.5	4.8	260	8882	D 3228

latching
1 coil

3	2.25	8.1	2.25	100	90	D 3241
4.5	3.375	12.1	3.375	100	203	D 3242
5	3.75	13.5	3.75	100	250	D 3243
6	4.5	16.2	4.50	100	360	D 3244
9	6.75	24.2	6.75	100	810	D 3245
12	9.00	29.0	9.00	100	1440	D 3246
24	18.00	47.5	18.00	150	3840	D 3247

Further coil versions are available on request.

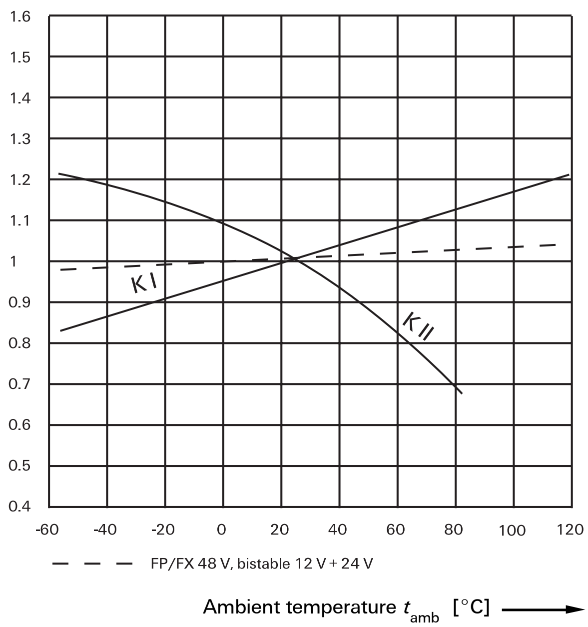
U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current

U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\,tamb}$ = $K_I \cdot U_{I\ 23°C}$
and
$U_{II\,tamb}$ = $K_{II} \cdot U_{II\ 23°C}$

t_{amb} = Ambient temperature
$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}
$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}
k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Number of contacts and type	2 changeover contacts
Contact assembly	Bifurcated contacts
Contact material	Palladium-ruthenium - gold covered
Limiting continuous current at max. ambient temperature	2 A
Maximum switching current	2 A
Maximum swichting voltage	220 Vdc 250 Vac
Maximum switching capacity	60 W, 62.5 VA
Thermoelectric potential	< 10 μV
Initial contact resistance / measuring condition: 10 mA / 20 mV	< 70 mΩ
Electrical endurance at contact application 0 ($\geq$ 30 mV / $\geq$ 10 mA)	min. 2.5 x 10^6 operations
at cable load open end	min. 2.0 x 10^6 operations
at 24 V / 1.25 A	min. 5 x 10^5 operations
at 125 V / 0.24 A	min. 5 x 10^5 operations
at 30 V / 2 A	min. 5 x 10^5 operations
Mechanical endurance	typ. 10^8 operations
UL/CSA ratings	30 Vdc / 1 A 110 Vdc / 0.3 A 120 Vac / 0.5 A 240 Vac / 0.25 A

Insulation

Insulation resistance at 500 Vdc	> 10^9 Ω
Dielectric test voltage (1 min)	
between coil and contacts	1800 Vrms
between adjacent contact sets	1800 Vrms
between open contacts	1800 Vrms
Surge voltage resistance	
according to Bellcore GR 1089 (2 / 10 μs)	
between coil and contacts	3500 V
between adjacent contact sets	2500 V
between open contacts	2500 V
according to FCC 68 (10 / 160 μs) and IEC (10 / 700 μs)	
between coil and contacts	3500 V
between adjacent contact sets	2500 V
between open contacts	2500 V

High Frequency Data

Capacitance	
between coil and contacts	max. 4 pF
between adjacent contact sets	max. 2 pF
between open contacts	max. 2 pF
RF Characteristics	
Isolation at 100 MHz / 900 MHz	- 34.0 dB / - 15.1 dB
Insertion loss at 100 MHz / 900 MHz	- 0.03 dB / - 0.60 dB
V.S.W.R. at 100 MHz / 900 MHz	1.07 / 1.45

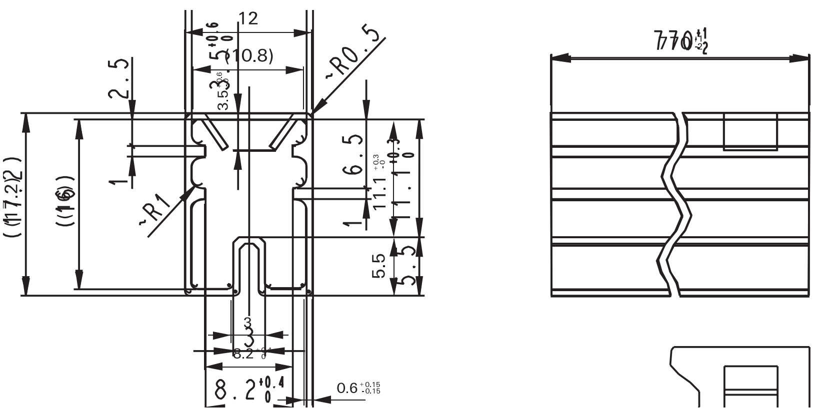
General data

Operate time at U_{nom} typ. / max.	3 ms / 4 ms
Reset time (latching) at U_{nom}, typ. / max.	3 ms / 4 ms
Release time without diode in parallel (non-latching), typ. / max.	1 ms / 3 ms
Release time with diode in parallel (non-latching), typ. / max.	3 ms / 4 ms
Bounce time at closing contact, typ. / max.	1 ms / 5 ms
Maximum switching rate without load	50 operations/s
Ambient temperature	-55° C ... +85° C
Thermal resistance	< 165 K/W
Maximum permissible coil temperature	110° C
Vibration resistance (function)	20 G 10 to 500 Hz
Shock resistance, half sinus, 11 ms	50 G (function) 1500 G (damage)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 20 s, no burning
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 2.5 g
Resistance to soldering heat	260° C / 10 s

All data refers to 23° C unless otherwise specified.

Packing
Stick dimension

Tube for THT version - 50 relays per stick, 1000 relays per box



Ordering Information

Relay Code	Tyco Part Number
D3202	0-1462034-1
D3204	0-1462034-2
D3205	0-1462034-5
D3206	0-1462034-6
D3207	0-1462034-8
D3209	0-1462034-9
D3210	1-1462034-3
D3212	1-1462034-4
D3213	1-1462034-5
D3221	1-1462034-9
D3222	2-1462034-0
D3223	2-1462034-1
D3224	2-1462034-2
D3225	2-1462034-3
D3226	2-1462034-4
D3227	2-1462034-5
D3228	2-1462034-6
D3241	2-1462034-8
D3242	2-1462034-9
D3243	3-1462034-0
D3244	3-1462034-1
D3245	3-1462034-2
D3246	3-1462034-3
D3247	3-1462034-4

2 pole telecom/signal relay
Through Hole Type (THT)
Non – polarized. non-latching 1 coil

Features

- Telecom/signal relay (dry circuit, test access, ringing)
- Slim line 15 x 7.5 mm, 0.59 x 0.295 inch
- Switching current 1.25 A
- 2 changeover contacts (2 form C / DPDT)
- Bifurcated contacts
- High sensitive 24 V and 48 V coil versions
- Meets Bellcore GR 1089, FCC Part 68 and ITU-T K20
  ≥ 2500 V between coil and contacts

Typical applications:

- Communications equipment
  Linecard application – analog, ISDN, xDSL
  PABX
  Voice over IP
- Office and business equipment
- Measurement and control equipment
- Consumer electronics
  Set top boxes, HiFi
- Medical equipment

Options:

High Dielectric Version (HDV) with > 5000 V surge voltage between coil and contacts

CSA-C22.2 No.14-95 File No. 176679-1079886
CSA-C22.2 No.950-95

UL 508 File No. E111441
UL1950 3rd ed.

CECC16504-001

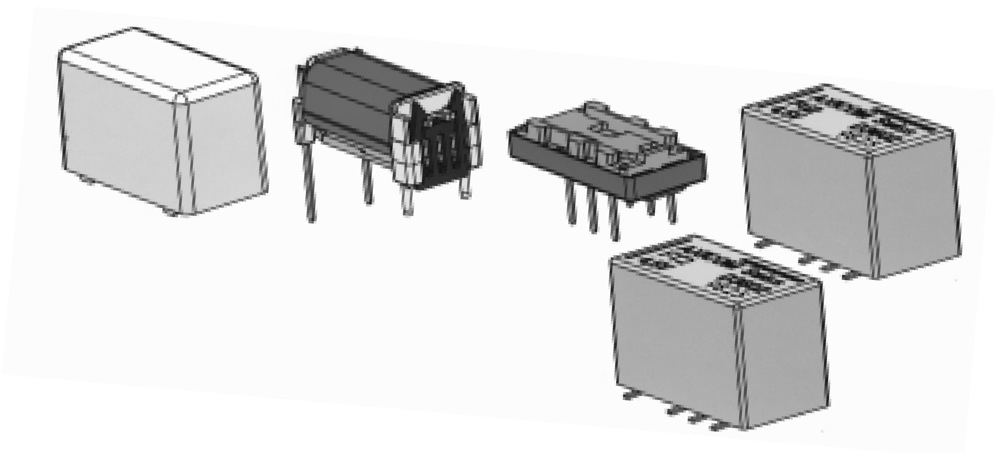
QC160504-CH0001

IEC/EN60950 IEC Ref. Cert. No. 10xx

Insulation cateogry:

Supplementary insulation according IEC / EN 60950 and UL 1950

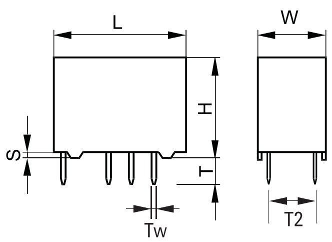
Working voltage	≥ 300 Vrms
Mains supply voltage	≥ 250 Vrms
Repetitive peak voltage:	1500 V
Pollution degree:	Internal: 1 External: 2
Flammability classification:	V-0
Maximum operating temperature:	85 °C



Dimensions

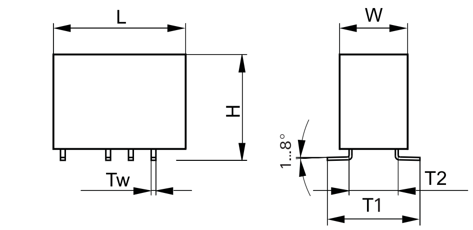
	FT2 THT		FU2 SMT long terminals		FU2 SMT short terminals	
	mm	inch	mm	inch	mm	inch
L	15 ± 0.05	0.590 ± 0.002	15 ± 0.15	0.590 ± 0.002	15 ± 0.05	0.590 ± 0.002
W	7.5 ± 0.05	0.295 ± 0.002	7.5 ± 0.05	0.295 ± 0.002	7.6 ± 0.05	0.296 ± 0.002
H	9.6 ± 0.03	0.377 ± 0.001	10 + 0.15	0.393 + 0.006	10 + 0.15	0.393 + 0.006
T	3.3 ± 0.3	0.129 ± 0.011	N/A	N/A	N/A	N/A
T1	N/A	N/A	9.2 ± 0.2	0.362 ± 0.008	7.5 ± 0.2	0.295 ± 0.008
T2	5.08	0.200	5.08	0.200	5.08	0.200
Tw	0.5	0.020	0.5	0.020	0.5	0.020
S	0.35 ± 0.03	0.013 ± 0.001	N/A	N/A	N/A	N/A

FT2: THT Version

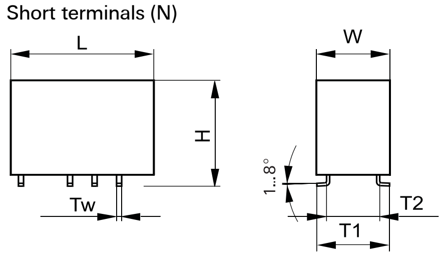


FU2: SMT Version

Long terminals (W)

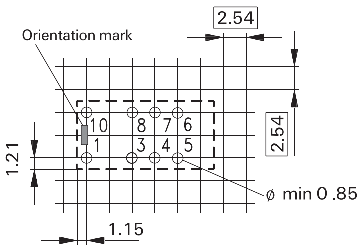


Short terminals (N)



Mounting hole layout

View onto the component side of the PCB

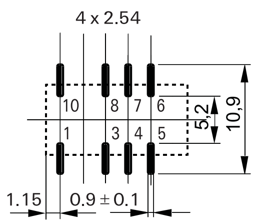


Basic grid 2.54 mm

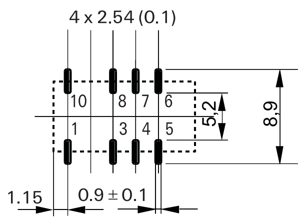
Solder pad layout

View onto the component side of the PCB

Long terminals



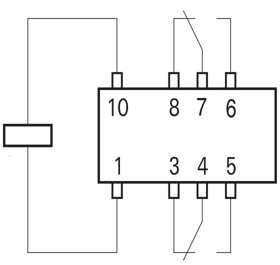
Short terminals



Terminal assignment

Relay - top view

non-latching 1 coil
release condition



Coil Data (values at 23°C)

Nominal voltage Unom	Operate voltage range		Release voltage Minimum	Nominal power consumption	Resistance	Coil number
	Minimum voltage U_I	Maximum voltage U_{II}				
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	

Sensitive version
non-latching 1 coil

FT2 D34** THT
FU2 D35** W SMT long term.
FU2 D35** N SMT short term.

3	2.25	4.2	0.30	200	45	21
4	3.00	5.7	0.40	200	114	29
4.5	3.38	6.4	0.45	200	101	22
5	3.75	7.1	0.50	200	125	23
6	4.5	8.5	0.60	200	180	24
9	6.75	12.7	0.90	200	405	25
12	9.00	17.0	1.20	200	720	26
24	18.00	33.9	2.40	240	2400	27
48	36.00	67.9	4.8	240	9600	28

Standard version
non-latching

FT2 D34** THT
FU2 D35** W SMT long term.
FU2 D35** N SMT short term.

3	2.25	5.2	0.3	300	30	01
4.5	3.38	7.8	0.45	300	68	02
5	3.75	8.7	0.50	300	83	03
6	4.5	10.4	0.60	300	120	04
9	6.75	15.6	0.90	300	270	05
12	9.00	20.8	1.20	300	480	06
24	18.00	40.8	2.40	300	1920	07
48	36.00	81.6	4.80	300	768	08

High dielectric version
non-latching

FT2 D34** THT HDV

3	2.25	4.2	0.30	200	45	91
5	3.75	7.1	0.50	200	125	93
12	9.00	17.0	1.20	200	720	96
24	18.00	33.9	2.40	240	2400	97

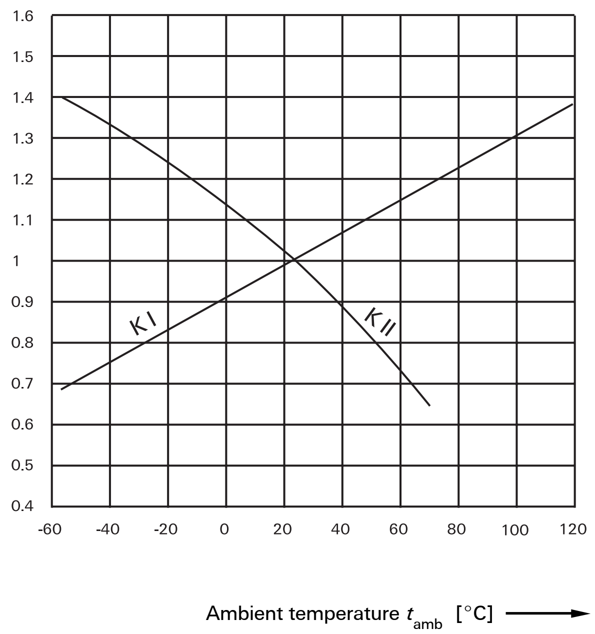
Further coil versions are available on request.

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current
U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\,tamb} = K_I \cdot U_{I\,23^\circ C}$
and
$U_{II\,tamb} = K_{II} \cdot U_{II\,23^\circ C}$

t_{amb} = Ambient temperature
$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}
$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}
k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Contact Data		Standard Version	High Dielectric Version
Number of contacts and type		2 changeover contacts	
Contact assembly		Bifurcated contacts	
Contact material		Silver nickel, gold-covered	Palladium-ruthenium, gold covered
Limiting continuous current at max. ambient temperature		1.25 A	2 A
Maximum switching current		2 A	2 A
Maximum swichting voltage		125 Vdc 250 Vac	220 Vdc 250 Vdc
Maximum switching capacity		30 W, 62.5 VA	60 W, 62.5 VA
Thermoelectric potential		< 10 μV	
Initial contact resistance / measuring condition: 10 mA / 20 mV		< 70 mΩ	
Electrical endurance	at contact application 0 (≥ 12 V / ≥ 10 mA)	min. 2.5 x 10^6 operations	
	at cable load open end	min. 2.0 x 10^6 operations	
Resistive load	125 Vdc / 0.24 A - 30 W	min. 1 x 10^5 operations	
	250 Vdc / 0.25 A - 62.5 VA	min. 1 x 10^5 operations	
	24 Vdc / 1.25 A - 30 W	min. 1 x 10^5 operations	
Mechanical endurance		typ. 10^8 operations	
UL/CSA ratings		125 Vdc / 1.25 A 125 Vac / 1.25 A	

Insulation

Insulation	Standard Version	High Dielectric Version
Insulation resistance at 500 VDC	> 10^9 Ω	> 10^9 Ω
Dielectric test voltage (1 min)		
between coil and contacts	1500 Vrms	3500 Vrms
between adjacent contact sets	1500 Vrms	1800 Vrms
between open contacts	1500 Vrms	1800 Vrms
Surge voltage resistance		
according to Bellcore TR-NWT-001089 (2 / 10 μs)		
between coil and contacts	2500 V	5000 V
between adjacent contact sets	1500 V	2500 V
between open contacts	1500 V	2500 V
according to FCC 68 (10 / 160 μs)		
between coil and contacts	2500 V	5000 V
between adjacent contact sets	1500 V	2500 V
between open contacts	1500 V	2500 V

High Frequency Data

High Frequency Data	
Capacitance	
between coil and contacts	max. 4 pF
between adjacent contact sets	max. 1 pF
between open contacts	max. 1 pF
RF Characteristics	
Isolation at 100 MHz / 900 MHz	- 30.6 dB / - 13.7 dB
Insertion loss at 100 MHz / 900 MHz	- 0.02 dB / - 0.50 dB
V.S.W.R. at 100 MHz / 900 MHz	1.02 / 1.27

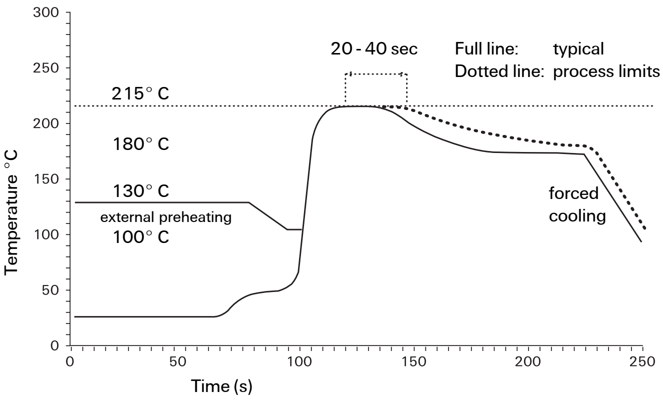
General data

Operate time at U_{nom} typ. / max.	3 ms / 5 ms
Release time without diode in parallel, typ. / max.	2 ms / 5 ms
Release time with diode in parallel, typ. / max.	4 ms / 5 ms
Bounce time at closing contact, typ. / max.	1 ms / 5 ms
Maximum switching rate without load	50 operations/s
Ambient temperature	-55° C ... +85° C
Thermal resistance	< 165 K/W
Maximum permissible coil temperature	125° C
Vibration resistance (function)	10 G
Shock resistance, half sinus, 11 ms	10 to 1000 Hz 15 G(function)
Degree of protection	500 G (damage) immersion cleanable, IP 67
Needle flame test	application time 20 s, no burning or glowing
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 3 g
Resistance to soldering heat	260° C / 10 s

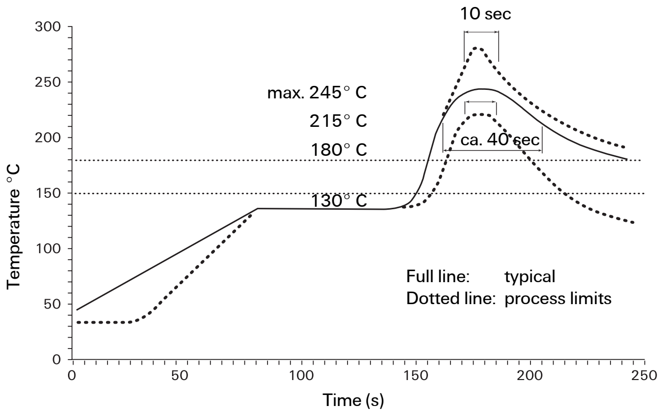
All data refers to 23° C unless otherwise specified.

Recommended soldering conditions

Soldering conditions according CECC 00802



Vapor Phase Soldering: Temperature/Time Profile
(Lead Temperature)

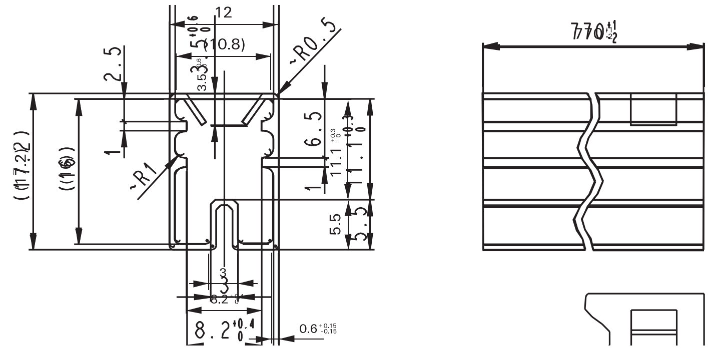


Infrared Soldering: Temperature/Time Profile
(Lead Temperature)

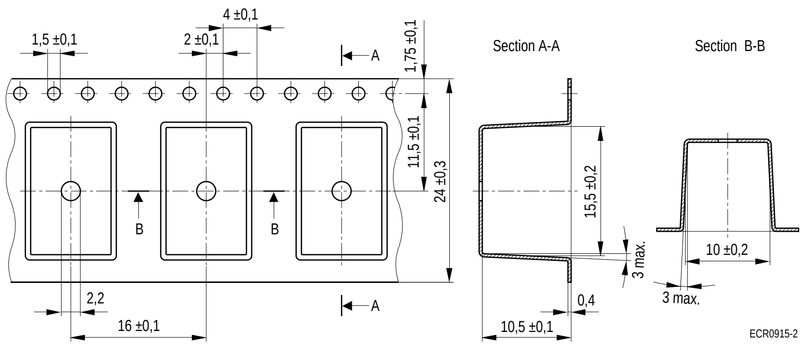
Packing

Dimensions in mm

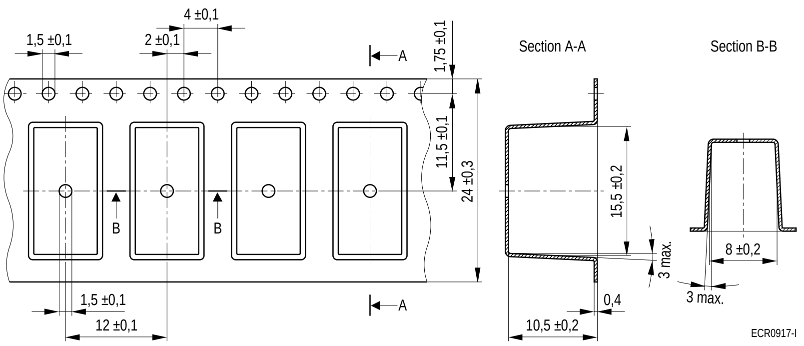
Tube for THT version - 50 relays per stick, 1000 relays per box



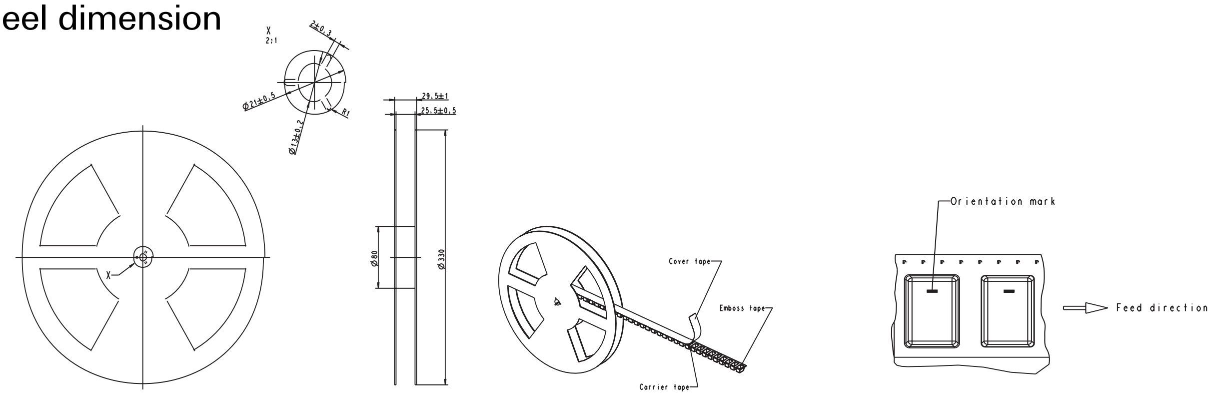
Tape and reel for SMT version with long terminals - 400 relays per reel, 2000 relays per box



Tape and reel for SMT version with short terminals - 500 relays per reel, 2500 relays per box



Reel dimension



Ordering Information

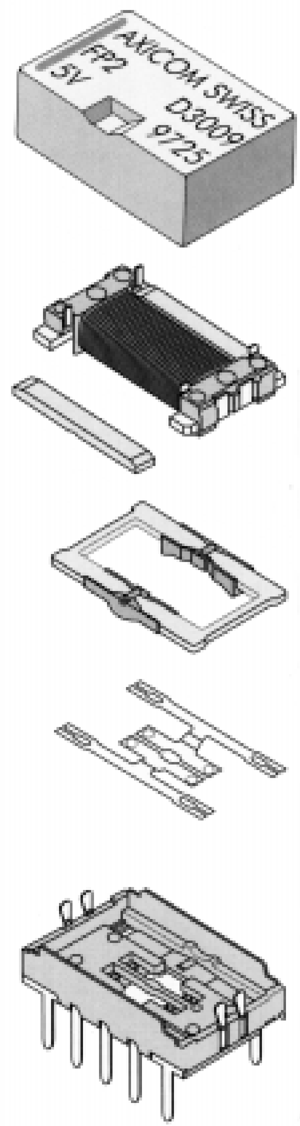
Relay Code	Tyco Part Number	Relay Code	Tyco Part Number
D3401	0-1462035-1	D3506N	1-1462036-1
D3402	0-1462035-2	D3506W	1-1462036-2
D3403	0-1462035-3	D3507N	1-1462036-3
D3404	0-1462035-4	D3507W	1-1462036-4
D3405	0-1462035-5	D3508N	1-1462036-5
D3406	0-1462035-6	D3508W	1-1462036-6
D3407	0-1462035-7	D3521N	1-1462036-7
D3408	0-1462035-8	D3521W	1-1462036-8
D3421	0-1462035-9	D3522N	1-1462036-9
		D3522W	2-1462036-0
D3422	1-1462035-0	D3523N	2-1462036-1
D3423	1-1462035-1	D3523W	2-1462036-2
D3424	1-1462035-2	D3524N	2-1462036-3
D3425	1-1462035-3	D3524W	2-1462036-4
D3426	1-1462035-4	D3525N	2-1462036-5
D3427	1-1462035-7	D3525W	2-1462036-6
D3428	1-1462035-8	D3526N	2-1462036-7
D3429	1-1462035-9	D3526W	2-1462036-8
D3501N	0-1462036-1	D3527N	2-1462036-9
D3501W	0-1462036-2	D3527W	9-1462036-1
D3502N	0-1462036-3	D3528N	9-1462036-3
D3502W	0-1462036-4	D3528W	9-1462036-5
D3503N	0-1462036-5	D3529N	3-1462036-0
D3503W	0-1462036-6	D3529W	3-1462036-1
D3504N	0-1462036-7	D3491	2-1462035-0
D3504W	0-1462036-8	D3493	1-1462035-5
D3505N	0-1462036-9	D3496	2-1462035-4
D3505W	1-1462036-0	D3497	2-1462035-5

D3 _ _ _ _

- Nil THT
- W long terminals
- N short terminals
- Coil voltage
  - 1 = 3 V
  - 2 = 4.5 V
  - 3 = 5 V
  - 4 = 6 V
  - 5 = 7 V
  - 6 = 12 V
  - 7 = 24 V
  - 8 = 48 V
  - 9 = 4 V
- Sensitivity
  - 0 = 300 mW - Standard Dielectric
  - 2 = 200 / 240 mW - Standard Dielectric
  - 9 = 200 / 240 mW - High Dielectric Version
- Terminal Shape
  - 4 = THT
  - 5 = SMT

2 pole telecom / signal relay
Through Hole Type (THT)
Polarized.

Relay types: non-latching with 1 coil
latching with 1 coil
latching with 2 coils



Features

- Telecom / signal relay (dry circuit, test access, ringing)
- Slim line 14 x 9 mm, 0.550 x 0.354 inch
- Switching current 1,25 A
- 2 changeover contacts (2 form C / DPDT)
- Bifurcated contacts
- High sensitivity results in low nominal power consumption
  80 mW for high sensitive, 140 mW for sensitive version
- High mechanical shock resistance
  up to 300 G functional
  up to 1500 G survival

Typical applications

- Communications equipment
  Linecard application - analog, ISDN, xDSL, PABX
  Voice over IP
- Office and business equipment
- Measurement and control equipment
- Consumer electronics
  Set top boxes, HiFi
- Medical equipment

CSA-C22.2 No 14-95 File No. 176679-1079886

UL 508 File No. E111441

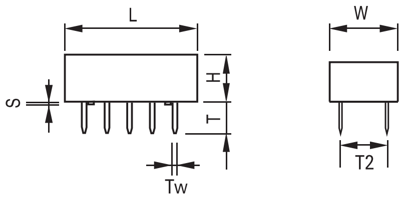
CECC 16503-001

QC 160503-CH0001

Dimensions

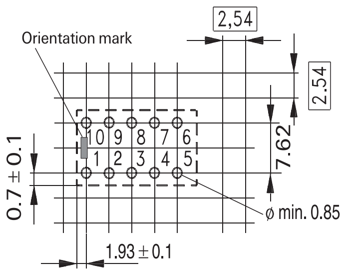
	THT mm	THT inch
L	14.02 ± 0.08	0.574 ± 0.008
W	9.02 ± 0.08	0.035 ± 0.003
H	5 ± 0.1	0.196 ± 0.004
T	3.2 + 0.3	0.125 + 0.011
T1	N/A	N/A
T2	7.62 ±0.1	0.3 ± 0.004
Tw	0.5	0.020
S	0.25+0.05	0.009+0.002

THT Version



Mounting hole layout

View onto the component side of the PCB
(top view)

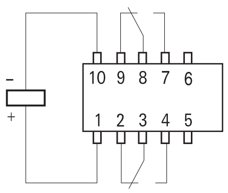


Basic grid 2.54 mm

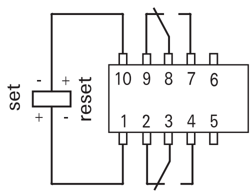
Terminal assignment

Relay - top view

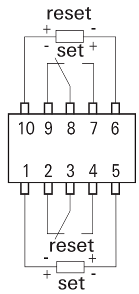
Non-latching type,
not energized condition



Latching type,
reset condition



latching, 2 coils
reset condition



Coil Data (values at 23°C)

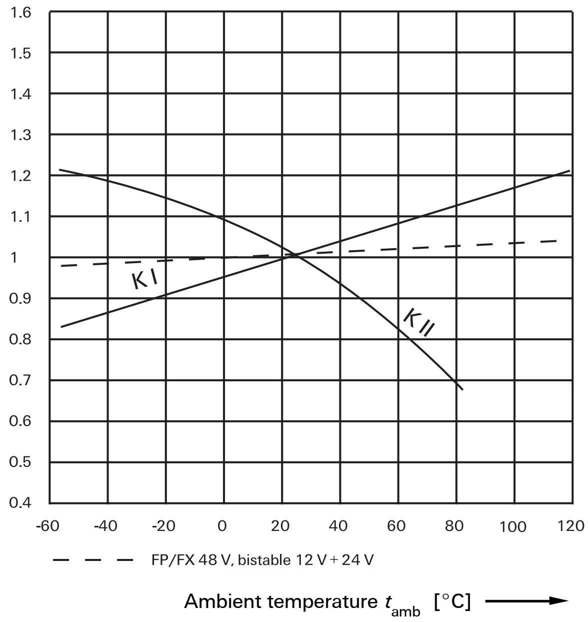
Nominal voltage Unom Vdc	Operate/set voltage range Minimum voltage U_I Vdc	Maximum voltage U_{II} Vdc	Release/ reset voltage Minimum Vdc	Nominal power consumption mW	Resistance Ω / ± 10 %	Relay Code
non-latching 1 coil						
3	2.1	6.8	0.30	140	64	D 3006
4.5	3.15	10.3	0.45	140	145	D 3004
5	3.5	11.4	0.50	140	178	D 3009
6	4.2	13.7	0.60	140	257	D 3005
9	6.3	20.4	0.90	140	574	D 3010
12	8.4	27.3	1.20	140	1028	D 3002
24	16.8	45.7	2.40	200	2880	D 3012
48	33.6	67.5	4.80	300	7680	D 3013
non-latching 1 coil high sensitive version						
3	2.25	9.0	0.3	80	113	D 3021
4.5	3.38	13.5	0.45	80	253	D 3022
5	3.75	15.0	0.5	80	313	D 3023
6	4.5	18.0	0.6	80	450	D 3024
9	6.75	27.1	0.9	80	1013	D 3025
12	9.00	36.1	1.2	80	1800	D 3026
24	18.00	54.7	2.4	140	4114	D 3027
48	36.00	72.5	4.8	260	8882	D 3028
latching 1 coil						
3	2.25	8.1	2.25	100	90	D 3041
4.5	3.375	12.1	3.375	100	203	D 3042
5	3.75	13.5	3.75	100	250	D 3043
6	4.5	16.2	4.50	100	360	D 3044
9	6.75	24.2	6.75	100	810	D 3045
12	9.00	29.0	9.00	100	1440	D 3046
24	18.00	47.5	18.00	150	3840	D 3047
latching 2 coils						
3	2.1	5.7	2.1	200	45	D 3061
4.5	3.15	8.6	3.15	200	101	D 3062
5	3.5	9.5	3.5	200	125	D 3063
6	4.2	11.4	4.2	200	180	D 3064
9	6.3	17.1	6.3	200	405	D 3065
12	8.4	22.6	8.4	200	720	D 3066
24	16.8	33.7	16.8	200	1920	D 3067

Further coil versions are available on request.

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current
U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\,tamb} = K_I \cdot U_{I\,23°C}$
and
$U_{II\,tamb} = K_{II} \cdot U_{II\,23°C}$
t_{amb} = Ambient temperature
$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}
$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}
k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Number of contacts and type	2 changeover contacts
Contact assembly	Bifurcated contacts
Contact material	Silver-nickel, gold-covered
Limiting continuous current at max. ambient temperature	2 A
Maximum switching current	2 A
Maximum swichting voltage	125 Vdc 250 Vac
Maximum switching capacity	30 W, 62.5 VA
Thermoelectric potential	< 10 μV
Initial contact resistance / measuring condition: 10 mA / 20 mV	< 50 mΩ
Electrical endurance at contact application 0 (≥30 mV/ ≥10 mA)	min. 2.5 x 10^6 operations
at cable load open end	min. 2.0 x 10^6 operations
at 125 Vdc / 0.24 A - 30 W	min. 1.0 x 10^5 operations
at 250 Vac / 0.25 A - 62.5 VA	min. 1.0 x 10^5 operations
at 24 V / 1.25 A - 30 W	min. 3.0 x 10^5 operations
Mechanical endurance	typ. 10^8 operations
UL/CSA ratings	30 Vdc / 1.25 A 50 Vdc / 0.5 A 50 Vac / 0.5 A

Insulation

Insulation resistance at 500 VDC	> 10^9 Ω
Dielectric test voltage (1 min)	
between coil and contacts	1000 Vrms
between adjacent contact sets	1000 Vrms
between open contacts	750 Vrms
Surge voltage resistance	
according IEC (10 / 700 μs)	
between coil and contacts	1500 V
between adjacent contact sets	1500 V
between open contacts	1500 V
according to FCC 68 (10 / 160 μs)	
between coil and contacts	1500 V
between adjacent contact sets	1500 V
between open contacts	1500 V

High Frequency Data

Capacitance	
between coil and contacts	max. 4 pF
between adjacent contact sets	max. 1 pF
between open contacts	max. 1 pF
RF Characteristics	
Isolation at 100 / 900 MHz	-40.2 dB / -22.3 dB
Insertion loss at 100 / 900 MHz	-0.03 dB / -0.25 dB
V.S.W.R. at 100 / 900 MHz	1.01 / 1.07

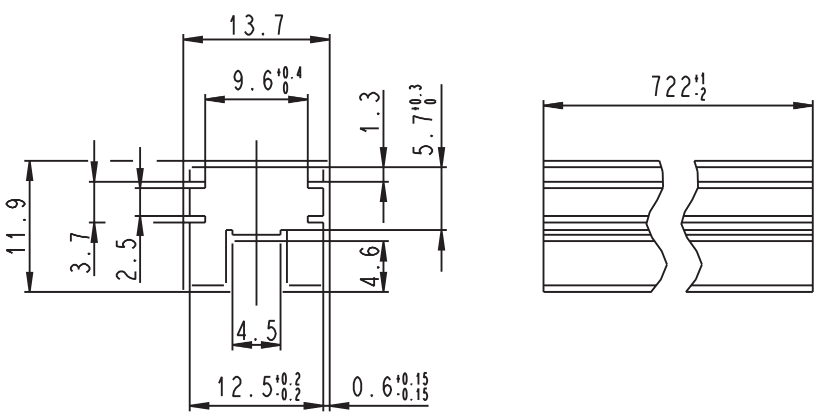
General data

Operate time at U_{nom} typ. / max.	3 ms / 4 ms
Reset time (latching) at U_{nom}, typ. / max.	3 ms / 4 ms
Release time without diode in parallel (non-latching), typ. / max.	1 ms / 3 ms
Release time with diode in parallel (non-latching), typ. / max.	3 ms / 4 ms
Bounce time at closing contact, typ. / max.	1 ms / 5 ms
Maximum switching rate without load	50 operations/s
Ambient temperature	-55° C ... +85° C
Thermal resistance	< 165 K/W
Maximum permissible coil temperature	110° C
Vibration resistance (function)	20 G 10 to 500 Hz
Shock resistance, half sinus, 11 ms	50 G (function) 1500 G (damage)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 20 s, no burning or glowing
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 2 g
Resistance to soldering heat	260° C / 10 s

All data refers to 23° C unless otherwise specified.

Packing

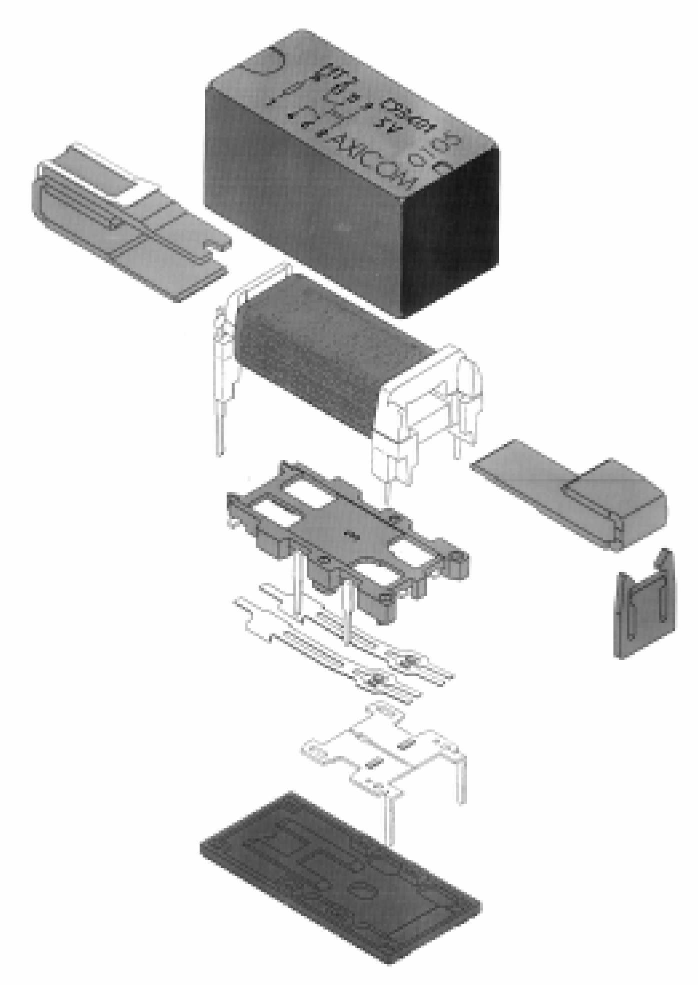
Tube for THT version - 50 relays per stick, 1000 relays per box



Ordering Information

Relay Code	Tyco Part Number	Relay Code	Tyco Part Number
D3002	0-1462033-5	D3041	4-1462033-0
D3004	0-1462033-9	D3042	4-1462033-1
D3005	1-1462033-1	D3043	4-1462033-2
D3006	1-1462033-3	D3044	4-1462033-3
D3009	1-1462033-4	D3045	4-1462033-4
		D3046	4-1462033-5
		D3047	4-1462033-6
D3010	2-1462033-1	D3061	4-1462033-7
D3012	2-1462033-2	D3062	4-1462033-8
D3013	2-1462033-6	D3063	4-1462033-9
D3021	3-1462033-2	D3064	5-1462033-0
D3022	3-1462033-3	D3065	5-1462033-1
D3023	3-1462033-4	D3066	5-1462033-4
D3024	3-1462033-5	D3067	5-1462033-6
D3025	3-1462033-6		
D3026	3-1462033-7		
D3027	3-1462033-8		
D3028	3-1462033-9		

2 pole telecom/signal relay
Through Hole Type (THT)
Non-polarized. non-latching 1 coil



Features

– Telecom/signal relay (dry circuit, test access, ringing)

– Slim line 20 x 10 mm, 0.795 x 0.393 inch

– Switching current 1.25A

– 2 changeover contacts (2 form C / DPDT)

– Bifurcated contacts

– Meets FCC Part 68 and ITU-T K20

Typical applications

– Communications equipment
  Linecard application – analog, ISDN, xDSL
  PABX
  Voice over IP

– Office and business equipment

– Measurement and control equipment

– Consumer electronics

– Set top boxes, HiFi

– Medical equipment

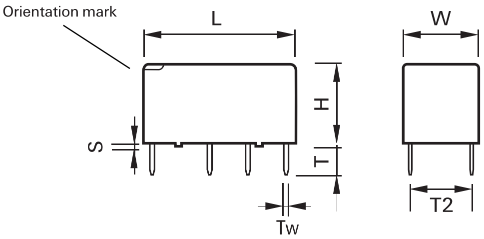
- Automotive Equipment

CSA-C22.2 No 14-95 File No. 176679-1079886

UL 508 File No. E 111441

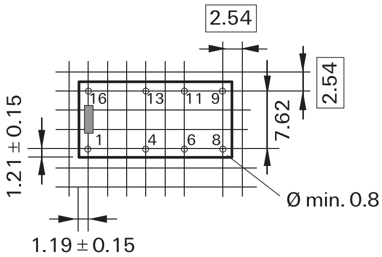
CECC 16502-001

THT Version



Mounting hole layout

View onto the component side of the PCB
(top view)

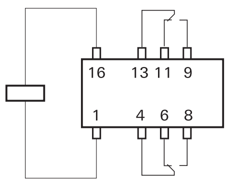


Basic grid 2.54 mm

Terminal assignment

Relay - top view

non-latching 1 coil
release condition



Dimension

	THT	
	mm	inch
L	20.2 + 0.05/-0.02	0.795 + 0.002/-0.0008
W	10 + 0.05/-0.02	0.393 + 0.002/-0.0008
H	11+0.1/-0.2	0.433 + 0.004/-0.008
T	3.1 ± 0.3	0.122 ± 0.011
T1	N/A	N/A
T2	7.62 ± 0.15	0.3 ± 0.005
S	0.55	0.021
Tw	0.5	0.020

Coil Data (values at 23°C)

Nominal voltage *U*nom	Operate/voltage range		Release voltage Minimum	Nominal power consumption	Resistance	Relay Code
	Minimum voltage U_I	Maximum voltage U_{II}				
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	

High sensitive version (150 mW)
non-latching 1 coil

3	2.1	6.7	0.30	150	60	C 93400
4.5	3.2	10.1	0.45	150	136	C 93406
5	3.6	11.3	0.50	150	168	C 93401
6	4.3	13.4	0.60	150	240	C 93427
9	6.4	20.3	0.90	150	544	C 93405
12	8.6	27.1	1.20	150	968	C 93402
24	17.1	54.1	2.40	150	3872	C 93403
48	33.1	108.3	4.80	150	15468	C 93404

Sensitive version (200 mW)
non-latching 1 coil

3	2.0	5.8	0.30	200	45	C 93414
4.5	2.9	8.7	0.45	200	101	C 93415
5	3.3	9.7	0.50	200	125	C 93416
6	3.9	11.6	0.60	200	180	C 93428
9	5.9	17.5	0.90	200	405	C 93417
12	7.8	23.3	1.20	200	720	C 93418
24	15.6	46.7	2.40	200	2880	C 93419
48	31.2	93.4	4.80	200	11520	C 93420

Sensitive version (300 mW)
non-latching 1 coil

4.5	3.1	7.4	0.45	300	73	C 93433
5	3.4	8.2	0.50	300	90	C 93434
12	8.25	19.7	1.20	300	515	C 93412
24	16.5	39.5	2.40	300	2060	C 93435
48	32.5	79.0	4.80	300	8240	C 93436

Standard version (400 mW)
non-latching 1 coil

4.5	2.9	6.1	0.45	400	50	C 93421
5	3.3	6.9	0.50	400	63	C 93422
6	3.9	8.2	0.60	400	90	C 93429
9	5.9	12.4	0.90	400	203	C 93423
12	7.8	16.5	1.20	400	360	C 93424
24	15.6	33.0	2.40	400	1440	C 93425
48	31.2	66.0	4.80	400	5760	C 93426

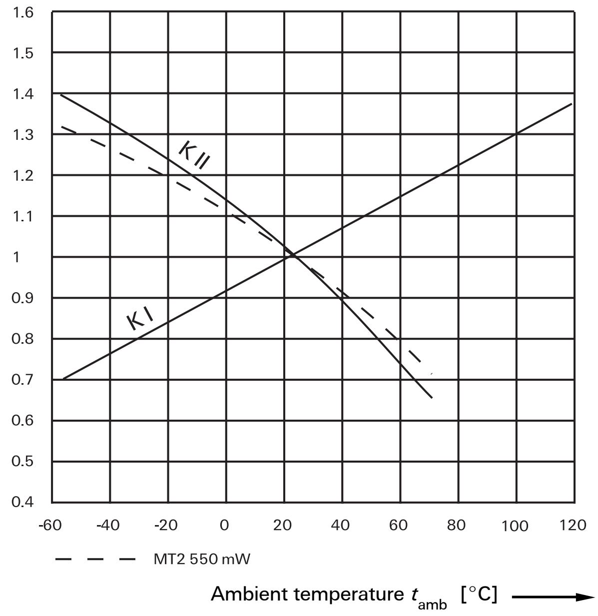
Standard version (550 mW)
non-latching 1 coil

4.5	2.9	6.0	0.45	550	36	C 93438
5	3.3	6.8	0.5	550	45	C 93450
6	3.9	8.1	0.60	550	66	C 93437
12	7.8	16.7	1.20	550	280	C 93432
24	15.6	32.4	2.40	550	1050	C 93431
48	31.2	64.1	4.80	550	4100	C 93430

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current
U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\,tamb}$ = $K_I \cdot U_{I\ 23°\,C}$
and
$U_{II\,tamb}$ = $K_{II} \cdot U_{II\ 23°\,C}$
t_{amb} = Ambient temperature
$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}
$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}
k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Number of contacts and type	2 changeover contacts
Contact assembly	Bifurcated contacts
Contact material	Silver-nickel, gold-covered
Limiting continuous current at max. ambient temperature	1.25 A
Maximum switching current	2 A
Maximum swichting voltage	150 Vdc 150 Vac
Maximum switching capacity	30 W, 62.5 VA
Thermoelectric potential	< 10 μV
Initial contact resistance / measuring condition: 10 mA / 20 mV	< 70 mΩ
Electrical endurance Contact application 0 (30 mV/ 10 mA) Cable load open end Resistive load 150 V / 0.2 A - 30 W 24 V / 1.25 A - 30 W	min. 5 x 10^6 operations min. 2.5 x 10^6 operations min. 2.0 x 10^5 operations min. 2.0 x 10^5 operations
Mechanical endurance	typ. 10^8 operations
UL/CSA ratings	125 Vac / 0.4 A 24 Vdc / 1.25 A

Insulation

Insulation resistance at 500 Vdc	> 10^9 Ω
Dielectric test voltage (1 min) between coil and contacts between adjacent contact sets between open contacts	 1050 Vrms 750 Vrms 750 Vrms
Surge voltage resistance according to FCC 68 (10 / 160 μs) and IEC (10 / 700 μs) between coil and contacts between adjacent contact sets between open contacts	 1500 V 1500 V 1500 V

High Frequency Data

Capacitance	
between coil and contacts	max. 4 pF
between adjacent contact sets	max. 2 pF
between open contacts	max. 2 pF
RF Characteristics	
Isolation at 100 / 900 MHz	- 31.8 dB / - 14.2 dB
Insertion loss at 100 / 900 MHz	- 0.02 dB / - 0.97 dB
V.S.W.R. at 100 / 900 MHz	1.03 / 1.31

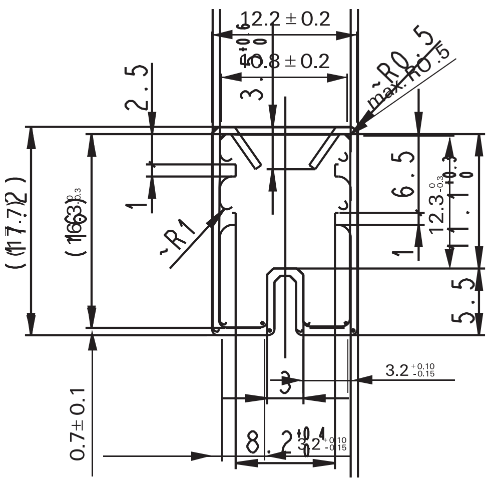
General data

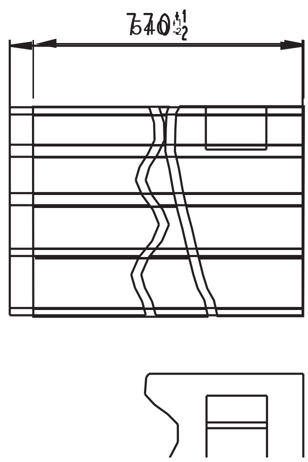
Operate time at U_{nom} typ. / max.	4 ms / 5 ms
Release time without diode in parallel (non-latching), typ. / max.	1 ms / 3 ms
Release time with diode in parallel (non-latching), typ. / max.	4 ms / 6 ms
Bounce time at closing contact, typ. / max.	1 ms / 5 ms
Maximum switching rate without load	50 operations/s
Ambient temperature	-55° C ... +85° C
Thermal resistance	< 125 K/W
Maximum permissible coil temperature	125° C
Vibration resistance (function)	10 G 10 to 500 Hz
Shock resistance, half sinus, 11 ms	50 G (function) 100 G (damage)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 10 s,
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 5 g
Resistance to soldering heat	260° C / 10 s

All data refers to 23° C unless otherwise specified.

Packing

Tube for THT version - 25 relays per stick, 1´000 relays per box

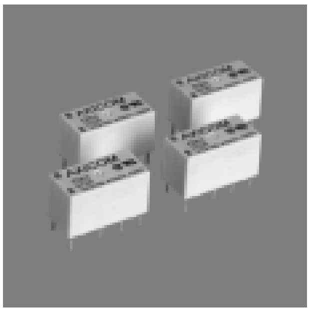




Ordering Information

Relay Code	Tyco Part Number	Relay Code	Tyco Part Number
C 93400	1-1462001-2	C 93423	5-1462000-0
C 93401	0-1462000-1	C 93424	5-1462000-1
C 93402	0-1462000-7	C 93425	5-1462000-3
C 93403	1-1462000-3	C 93426	5-1462000-5
C 93404	1-1462000-8	C 93427	5-1462000-6
C 93405	2-1462000-0	C 93428	5-1462000-7
C 93406	2-1462000-2	C 93429	5-1462000-8
C 93412	2-1462000-6	C 93430	5-1462000-9
C 93414	1-1462001-1	C 93431	6-1462000-1
C 93415	3-1462000-0	C 93432	6-1462000-2
C 93416	3-1462000-1	C 93433	6-1462000-6
C 93417	3-1462000-6	C 93434	6-1462000-8
C 93418	3-1462000-7	C 93435	7-1462000-0
C 93419	4-1462000-1	C 93436	7-1462000-2
C 93420	4-1462000-5	C 93437	7-1462000-6
C 93421	4-1462000-7	C 93438	7-1462000-7
C 93422	4-1462000-8	C 93450	8-1462000-5

2 pole telecom relay, non-polarized,
Through Hole Type (THT)



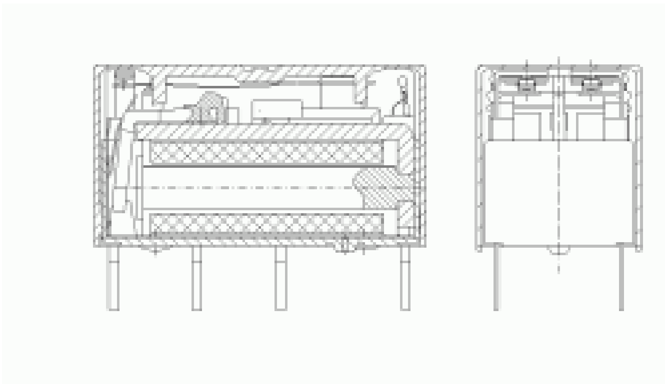
Relay types: non-latching with 1 coil

Features

- Standard DIL relay
- Dimensions 20.3 x 10.1 x 10.43 mm, 0.800 x 0.400 x 0.450 inch
- Switching and continous current 3 A
- 2 changeover contacts (2 form C / DPDT)
- Single contacts
- Immersion cleanable
- Four different coil sensitivities (150, 200, 400, > 500 mW)
- Surge voltage resistance meets FCC Part 68 requirement: 1.5 kV (10 / 160 µsec) between coil and contacts

Typical applications

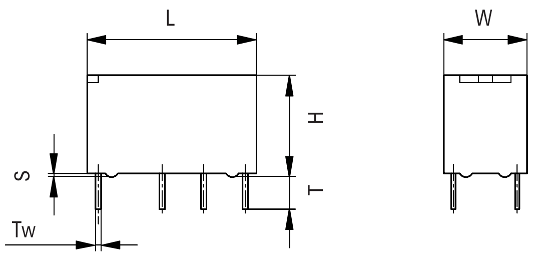
- Communications equipment
- Office equipment
- Measurement and control equipment
- Entertainment electronics
- Medical Equipment
- Consumer electronics



LR 45064-27

E 48393

THT Version

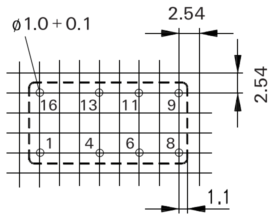


Dimensions

	THT V23105-A5xxx-A201 mm	inch
L	20.2 ± 0.1	0.795 ± 0.004
W	10.0 ± 0.1	0.394 ± 0.004
H	11.43 ± 0.2	0.450 - 0.008
T	3.5 ± 0.3	0.138 ± 0.012
Tw	0.72 - 0.2	0.028 - 0.008
S	0.3 ± 0.1	0.012 ± 0.004

Mounting hole layout

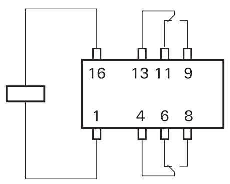
View onto the component side of the PCB (top view)



Basic grid 2.54 mm

Terminal assignment

Relay - top view



Coil Data (values at 23°C)

Nominal voltage Unom Vdc	Operate/set voltage range Minimum voltage U_I Vdc	Maximum voltage U_{II} Vdc	Release/ reset voltage Minimum Vdc	Nominal power consumption mW	Resistance Ω / ± 10 %	Coil number
150 mW nominal power consumption						
5	4.0	13.0	0.25	150	167	001
6	4.8	15.6	0.30	150	240	002
9	7.2	23.4	0.45	150	540	006
12	9.6	31.2	0.60	150	960	003
24	19.2	59.5	1.20	165	3480	005
200 mW nominal power consumption						
3	2.1	6.7	0.15	200	45	308
5	3.5	11.2	0.25	200	125	301
6	4.2	13.5	0.30	200	180	302
9	6.3	20.3	0.45	200	405	306
12	8.4	27.0	0.60	200	720	303
24	16.8	54.1	1.20	200	2880	305
48	33.6	108.3	2.40	200	11520	307
400 mW nominal power consumption						
5	3.5	7.9	0.25	400	62	401
6	4.2	9.5	0.30	400	90	402
9	6.3	14.3	0.45	400	203	406
12	8.4	19.1	0.60	400	360	403
24	16.8	38.3	1.20	400	1440	405
48	33.6	76.6	2.40	400	5760	407
> 500 mW nominal power consumption						
5	3.5	6.3	0.25	695	36	501
6	4.2	8.9	0.30	515	70	502
9	6.3	12.5	0.45	580	140	506
12	8.4	17.8	0.60	515	280	503
24	16.8	34.4	1.20	550	1050	505
48	33.6	67.3	2.40	575	4000	507

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current

U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

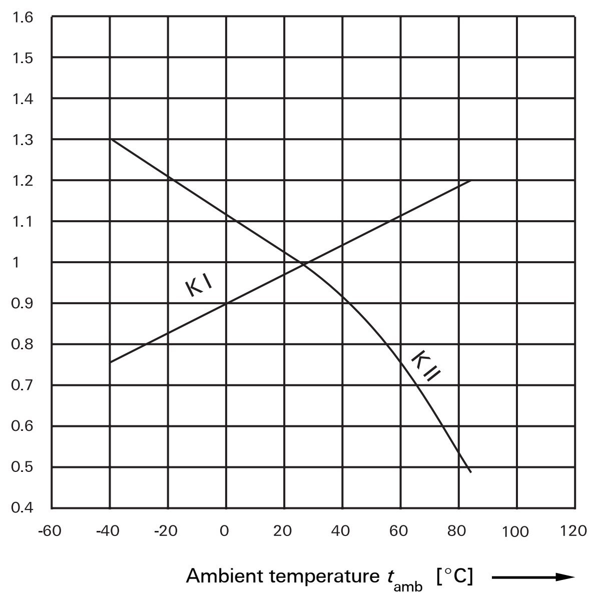
$U_{I\,tamb} = K_I \cdot U_{I\,23°C}$
and
$U_{II\,tamb} = K_{II} \cdot U_{II\,23°C}$

t_{amb} = Ambient temperature

$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}

$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}

k_I, k_{II} = Factors (dependent on temperature), see diagram



Coil versions, BT 47 type / specification T4563 C (current tested)

Nominal voltage Vdc	Operating current mA	Nominal power consumption mW	Resistance Ω / ± 10 %	British Telecom Code	Coil number
5	80	695	36	47 W / 5	475
10	32.5	500	200	47 W / 9	479
12	27	515	280	47 W / 6	476
24	14	550	1050	47 W / 7	477
48	7	575	4000	47 W / 8	478

Contact Data

Number of contacts and type	2 changeover contacts
Contact assembly	single contacts
Contact material	Silver-nickel, gold-covered
Limiting continuous current at max. ambient temperature	3 A
Maximum switching current	3 A
Maximum swichting voltage	220 Vdc 250 Vac
Maximum switching capacity	60 W, 125 VA
Thermoelectric potential	> 10 μV
Initial contact resistance / measuring condition: 10 mA / 20 mV	< 100 mΩ
Electrical endurance at 230 Vac / 0.5 A at 6 Vdc / 0.1 A at 30 Vdc / 1 A at 30 Vdc / 2 A	typ. 3.0 x 10^5operations typ. 2.0 x 10^6 operations typ. 5.0 x 10^5 operations typ. 1.0 x 10^5 operations
Mechanical endurance	typ. 15.0 x 10^6 operations
UL/CSA ratings	30 Vdc / 1.0 A 100 Vdc / 0.3 A 125 Vac / 0.5 A for 150 mW and 200 mW coil 125 Vac / 1.0 A for 400 mW and 500 mW coil

Insulation

Insulation resistance at 500 Vdc	> 10^9 Ω
Dielectric test voltage (1 min)	
between coil and contacts	1000 Vrms
between adjacent contact sets	750 Vrms
between open contacts	750 Vrms
Surge voltage resistance	
according to FCC 68 (10 / 160 μs)	
between coil and contacts	1500 V
between adjacent contact sets	1500 V
between open contacts	1500 V

High Frequency Data

Capacitance	
between coil and contacts	max. 2 pF
between adjacent contact sets	max. 1.5 pF
between open contacts	max. 1 pF
RF Characteristics	
Isolation at 100 / 900 MHz	-39.0 dB / -20.7 dB
Insertion loss at 100 / 900 MHz	-0.02 dB / -0.27 dB
V.S.W.R. at 100 / 900 MHz	1.04 / 1.40

General data

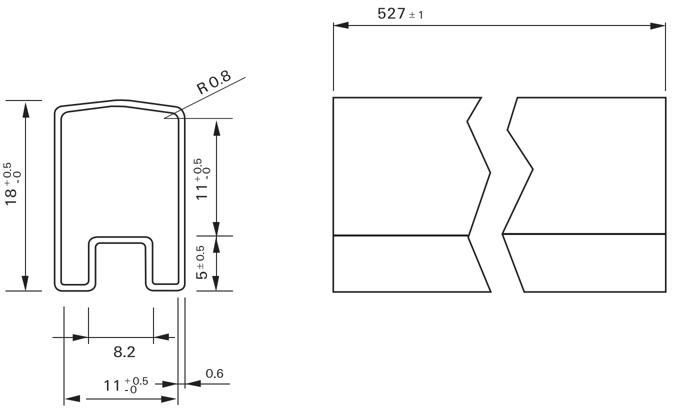
Operate time at U_{nom} typ. / max.	5 ms / 7 ms
Release time without diode in parallel, typ. / max.	4 ms / 6 ms
Release time with diode in parallel, typ. / max.	7 ms / 10 ms
Bounce time at closing contact, typ. / max.	3 ms / 5 ms
Maximum switching rate without load	20 operations/s
Ambient temperature	
150 and 200 mW coil	-25° C ... +85° C
400 mW coil	-25° C ... +75° C
500 mW coil	-25° C ... +60° C
Thermal resistance	< 100 K/W
Maximum permissible coil temperature	105° C
Vibration resistance (function)	10 g 10 to 55 Hz
Shock resistance, half sinus, 11 ms	10 g (function) 40 g (damage)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 20 s, burning time < 15 s
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 2.5 g
Resistance to soldering heat	260° C / 10 s

All data refers to 23° C unless otherwise specified.

Packing

Dimensions in mm

Tube for THT version - 25 relays per tube, 1000 relays per box



Ordering Information

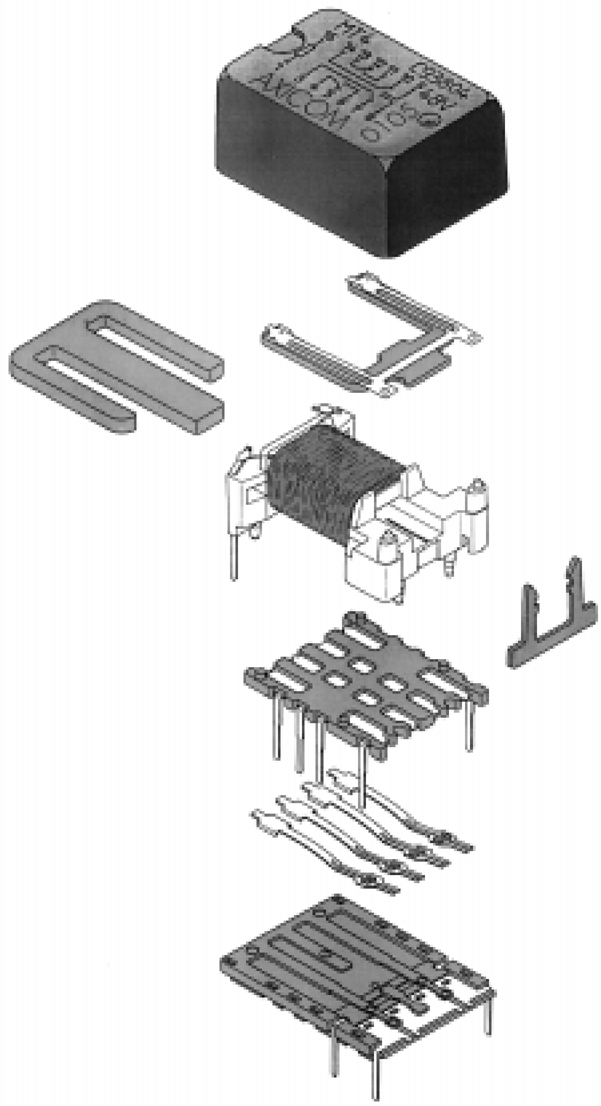
Relay Code	Tyco Part Number	Relay Code	Tyco Part Number
V23105A5001A201	8-1393792-5	V23105A5406A201	1-1393793-0
V23105A5002A201	8-1393792-7	V23105A5407A201	1-1393793-1
V23105A5003A201	8-1393792-8	V23105A5475A201	1-1393793-2
V23105A5005A201	9-1393792-0	V23105A5476A201	1-1393793-3
V23105A5006A201	9-1393792-1	V23105A5477A201	1-1393793-4
V23105A5301A201	9-1393792-3	V23105A5478A201	1-1393793-5
V23105A5302A201	9-1393792-5	V23105A5479A201	3-1393794-0
V23105A5303A201	9-1393792-7	V23105A5501A201	1-1393793-6
V23105A5305A201	9-1393792-9	V23105A5502A201	1-1393793-8
V23105A5306A201	0-1393793-2	V23105A5503A201	1-1393793-9
V23105A5307A201	0-1393793-3	V23105A5505A201	2-1393793-1
V23105A5308A201	0-1393793-5	V23105A5506A201	2-1393793-3
V23105A5401A201	0-1393793-6	V23105A5507A201	2-1393793-4
V23105A5402A201	0-1393793-7		
V23105A5403A201	0-1393793-8		
V23105A5405A201	0-1393793-9		

Ordering system:
V23105A5xxxA201 xxx = see coil table on page 4

MT4 Relay

AXICOM

4 pole telecom/signal relay
Through Hole Type (THT)
Non-polarized. non-latching 1 coil



Features

- Telecom/signal relay (dry circuit, test access, ringing)
- 20 x 14.8 mm, 0.795 x 0.582 inch
- Switching current 1.25 A
- 4 changeover contacts (4 form C / 4PDT)
- Bifurcated contacts
- Meets Bellcore GR 1089, FCC Part 68 and ITU-T K20
  2500 V between coil and contacts

Typical applications

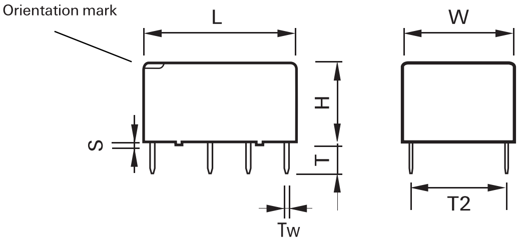
- Communications equipment
  Linecard application – analog, ISDN, xDSL
  PABX
  Voice over IP
- Office and business equipment
- Measurement and control equipment
- Consumer electronics
- Set top boxes, HiFi
- Medical equipment

CSA-C22.2 No 14-95 File No. 176679-1079886

UL 508 File No. E 111441

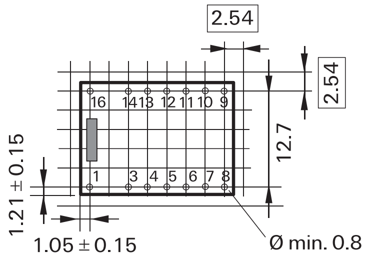
CECC 16501-001

THT Version



Mounting hole layout

View onto the component side of the PCB
(top view)

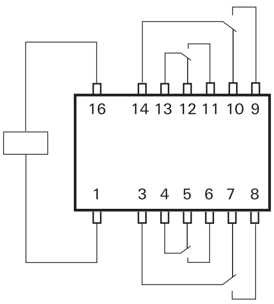


Basic grid 2.54 mm

Terminal assignment

Relay - top view

non-latching 1 coil
release condition



Dimension

	THT	
	mm	inch
L	20.0 ± 0.1	0.795 ± 0.004
W	14.8 ± 0.1	0.582 ± 0.004
H	11 +0.1/-0.2	0.433 +0.004/-0.008
T	3.1± 0.3	0.122 + 0.011
T1	N/A	N/A
T2	12.7 ± 0.15	0.5 ± 0.005
Tw	0.5	0.020
S	0.8	0.031

Coil Data (values at 23°C)

Nominal voltage *U*nom	Operate voltage range		Release voltage Minimum	Nominal power consumption	Resistance	Relay Code
	Minimum voltage U_I	Maximum voltage U_{II}				
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	

non-latching
1 coil

4.5	3.2	7.8	0.45	300	67	C 93807
5	3.6	8.65	0.50	300	83	C 93801
9	6.4	15.6	0.90	300	270	C 93805
12	8.6	20.8	1.20	300	480	C 93802
24	17.1	41.6	2.40	300	1920	C 93803
48	34.1	83.2	4.80	300	7680	C 93804

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current

U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

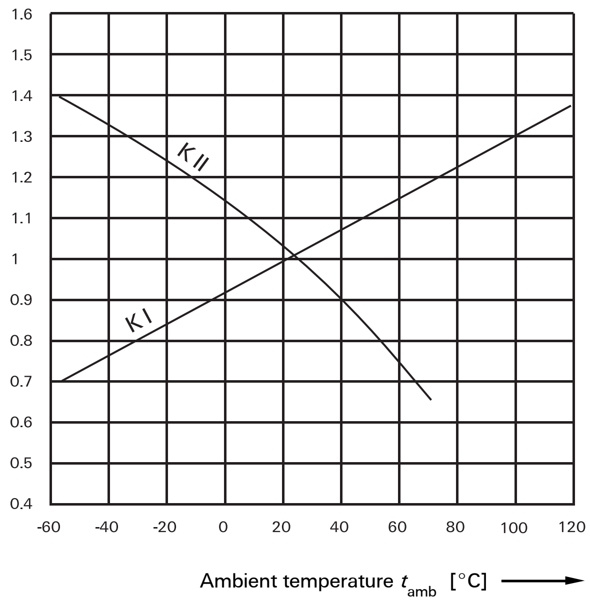
$U_{I\,tamb}$ = $K_I \cdot U_{I\ 23°C}$
and
$U_{II\,tamb}$ = $K_{II} \cdot U_{II\ 23°C}$

t_{amb} = Ambient temperature

$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}

$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}

k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Number of contacts and type	4 changeover contacts
Contact assembly	Bifurcated contacts
Contact material	Silver-nickel, gold-covered
Limiting continuous current at max. ambient temperature	1.25 A
Maximum switching current	1.25 A
Maximum swichting voltage	150 Vdc 150 Vac
Maximum switching capacity	30 W, 62.5 VA
Thermoelectric potential	$< 10\,\mu V$
Initial contact resistance / measuring condition: 10 mA / 20 mV	< 70 mΩ
Electrical endurance Contact application 0 (<=30 mV/<= 10 mA)	min. 1 x 10^7 operations
Cable load open end	min. 5 x 10^6 operations
Resistive load 150 V / 0.2 A - 30 W	min. 2.0 x 10^5 operations
24 V / 1.25 A - 30 W	min. 2.0 x 10^5 operations
Mechanical endurance	typ. 10^8 operations
UL/CSA ratings	24 Vdc / 1.25 A 125 Vac / 0.4 A

Insulation

Insulation resistance at 500 Vdc	$> 10^9\,\Omega$
Dielectric test voltage (1 min)	
between coil and contacts	1800 Vrms
between adjacent contact sets	750 Vrms
between open contacts	750 Vrms
Surge voltage resistance	
according to Bellcore TR-NWT-001089 (2 / 10 μs)	
between coil and contacts	2500 V
between adjacent contact sets	1500 V
between open contacts	1500 V
according to FCC 68 (10 / 160 μs) and IEC (10 / 700 μs)	
between coil and contacts	2500 V
between adjacent contact sets	1500 V
between open contacts	1500 V

High Frequency Data

Capacitance	
between coil and contacts	max. 4 pF
between adjacent contact sets	max. 2 pF
between open contacts	max. 2 pF
RF Characteristics	
Isolation at 100 / 900 MHz	- 31.2 dB / - 17.2 dB
Insertion loss at 100 / 900 MHz	- 0.05 dB / - 0.91 dB
V.S.W.R. at 100 / 900 MHz	1.03 / 1.31

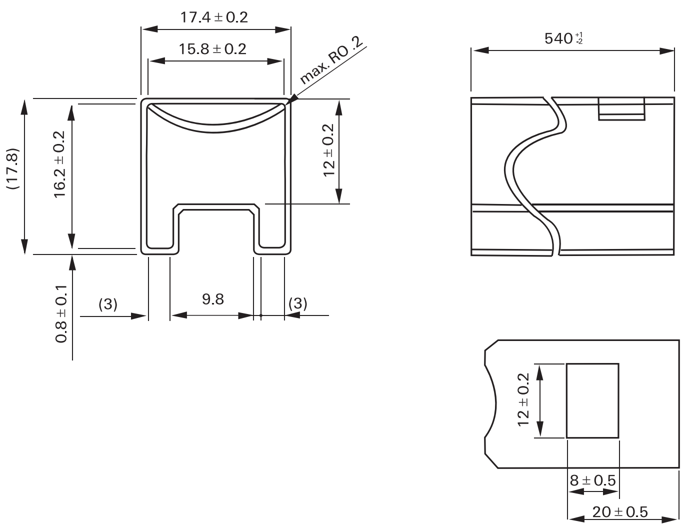
General data

Operate time at U_{nom} typ. / max.	4 ms / 6 ms
Release time without diode in parallel (non-latching), typ. / max.	1 ms / 3 ms
Release time with diode in parallel (non-latching), typ. / max.	4 ms / 6 ms
Bounce time at closing contact, typ. / max.	1 ms / 5 ms
Maximum switching rate without load	50 operations/s
Ambient temperature	-55° C ... +85° C
Thermal resistance	< 105 K/W
Maximum permissible coil temperature	100° C
Vibration resistance (function)	10 G 10 to 500 Hz
Shock resistance, half sinus, 11 ms	10 G (function) 100 G (damage)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 10 s,
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 7 g
Resistance to soldering heat	260° C / 10 s

All data refers to 23° C unless otherwise specified.

Packing

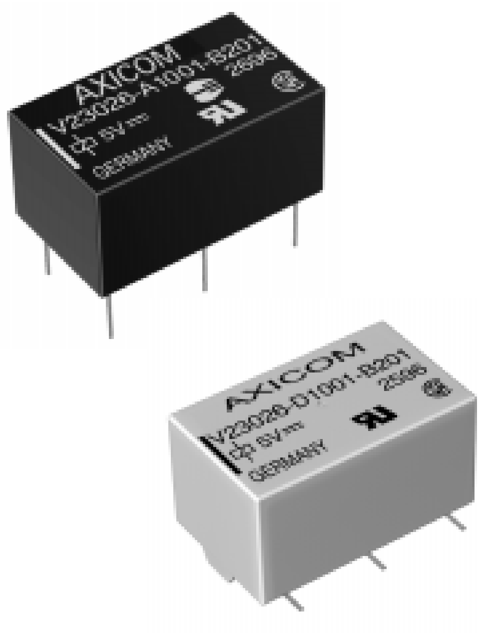
Tube for THT version - 25 relays per tube, 500 relays per box



Ordering Information

Relay Code	Tyco Part Number
C93801	0-1462032-1
C93802	0-1462032-4
C93803	0-1462032-7
C93804	0-1462032-8
C93805	0-1462032-9
C93807	1-1462032-0

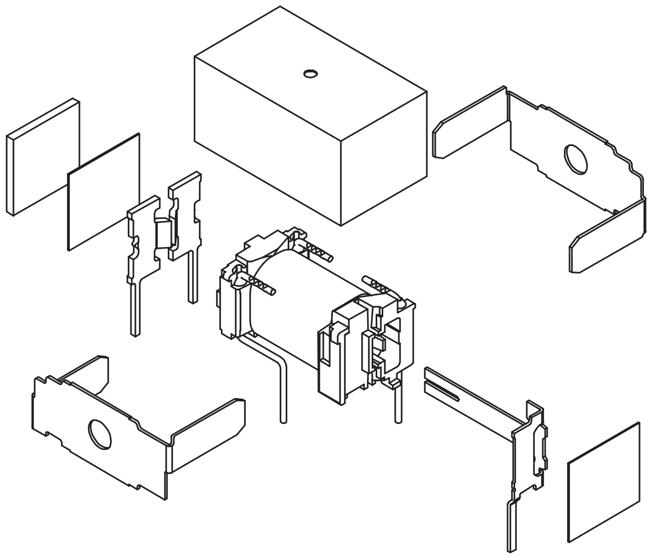
1 pole telecom and signal relay, polarized,
Through Hole Type (THT) or
Surface Mount Technology (SMT),



Relay types: non-latching with 1 coil
latching with 2 coils
latching with 1 coil

Features

– Directly triggerable with TTL standard modules such as ALS, HCT and ACT
– Slim line 13.5 x 7.85 mm, 0.531 x 0.309 inch
– Switching current 1 A
– 1 changeover contact (1 form C / SPDT)
– Bifurcated contacts
– Immersion cleanable
– High sensitivity results in low nominal power consumption
65 to 130 mW for non-latching
30 to 150 mW for latching
– Surge voltage resistance between contact and coil:
  - 2.5 kV (2 / 10 µsec) meets the Bellcore Requirement GR-1089
  - 1.5 kV (10 / 160 µsec) meets FCC Part 68



Typical applications

– Automotive equipment
CAN bus, imobilizer
– Office equipment
– Measurement and control equipment
– Medical equipment
– Safety equipment

Options

– FCC version on request. Testing of open contacts with surge voltage in accordance with FCC 68.302 (1.5 kV, 10/160 µsec)

LR 45064-5

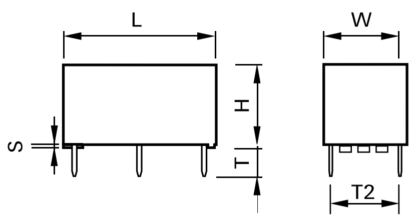
E 48393

Basic insulation coil/contacts according to IEC/EN 60950
Clearance > 0.75 mm
Creepage distance > 0.75 mm

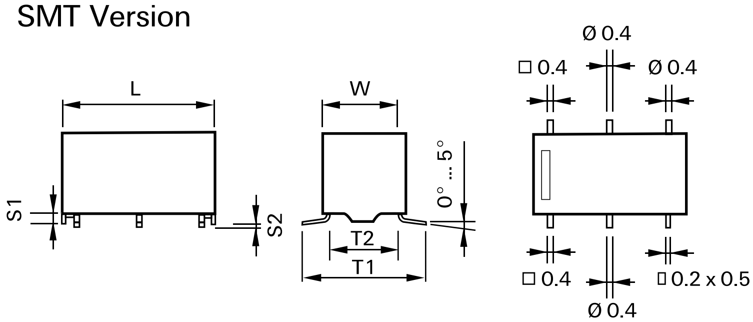
Dimensions

	V23026-x1xxx-B201			
	THT		SMT	
	mm	inch	mm	inch
L	13.0 ± 0.1	0.512 ± 0.004	13.4 ± 0.1	0.528 ± 0.004
W	7.6 ± 0.1	0.299 ± 0.004	7.75 ± 0.1	0.305 ± 0.004
H	6.9 - 0.2	0.272 - 0.008	8.0 - 0.2	0.315 - 0.008
T	3.5 - 0.2	0.138 -0.008	N/A	N/A
T1	N/A	N/A	10.9 - 0.5	0.429 - 0.020
T2	5.08 ± 0.15	0.200 ± 0.006	5.08 ± 0.15	0.200 ± 0.006
S	0.3 ± 0.1	0.012 ±0.004	N/A	N/A
S1	N/A	N/A	0.85 ± 0.1	0.033 ±0.004
S2	N/A	N/A	0.2 - 0.15	0.008 ±0.006

THT Version

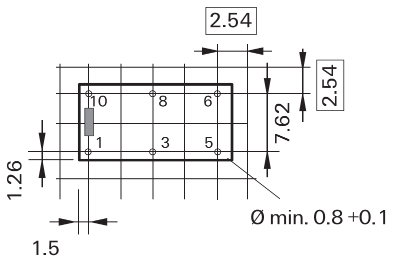


SMT Version



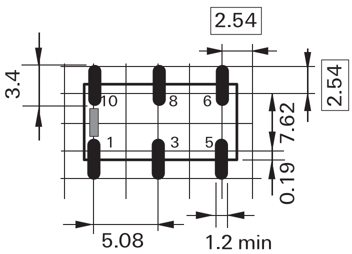
Mounting hole layout

View onto the component side of the PCB



Solder pad layout

View onto the component side of the PCB

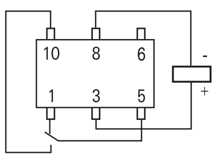


Terminal assignment

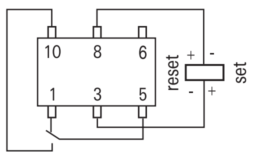
Relay - top view

Contact release or reset condition, coil polarity to set the relay

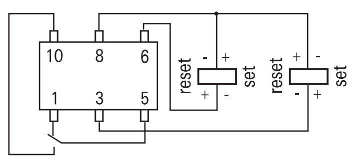
Non-latching type,
not energized condition



Latching type, 1 coil
reset condition



Latching type, 2 coils
reset condition



Coil Data (values at 23°C)

Nominal voltage Unom	Operate/set voltage range: Minimum voltage U_I	Operate/set voltage range: Maximum voltage U_{II}	Release/ reset voltage Minimum	Nominal power consumption	Resistance	Coil number
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	
THT, non-latching, 1 coil						A1***
3	2.25	8.80	0.30	66	137	006
5	3.75	14.50	0.50	68	370	001
12	9.00	35.00	1.20	64	2250	002
24	18.00	50.00	2.40	128	4500	004
THT, latching, 2 coils (coils I and II are identical)						B1***
3	2.25	8.55	2.25	69	130	106
5	3.75	14.75	3.75	64	390	101
12	9.00	29.00	9.00	96	1500	102
24	A nominal voltage of 24 V is feasible with a 12 V coil with a series resistor (1500 Ω)					
THT, latching, 1 coil						C1***
3	2.25	13.00	2.25	30	300	056
5	3.75	20.00	3.75	34	740	051
12	9.00	50.00	9.00	32	4500	052
24	18.00	50.00	18.00	128	4500	054
SMT, non-latching, 1 coil						D1***
3	2.25	8.00	0.30	80	113	026
5	3.75	13.30	0.50	80	313	021
12	9.00	35.00	1.20	80	1800	022
24	18.00	50.00	2.40	128	4500	024
SMT, latching, 2 coils (coils I and II are identical)						E1***
3	2.25	8.55	2.25	69	130	106
5	3.75	14.75	3.75	64	390	101
12	9.00	29.00	9.00	96	1500	102
24	A nominal voltage of 24 V is feasible with a 12 V coil with a series resistor (1500 Ω)					
SMT, latching, 1coil						F1***
5	3.75	20.00	3.75	34	740	051
12	9.00	50.00	9.00	32	4500	052
24	A nominal voltage of 24 V is feasible with a 12 V coil with a series resistor (4500 Ω)					

Further coil versions e.g. 1.5 V, 9 V and 15 V are available on request.

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current

U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\,tamb} = K_I \cdot U_{I\ 23°C}$

and

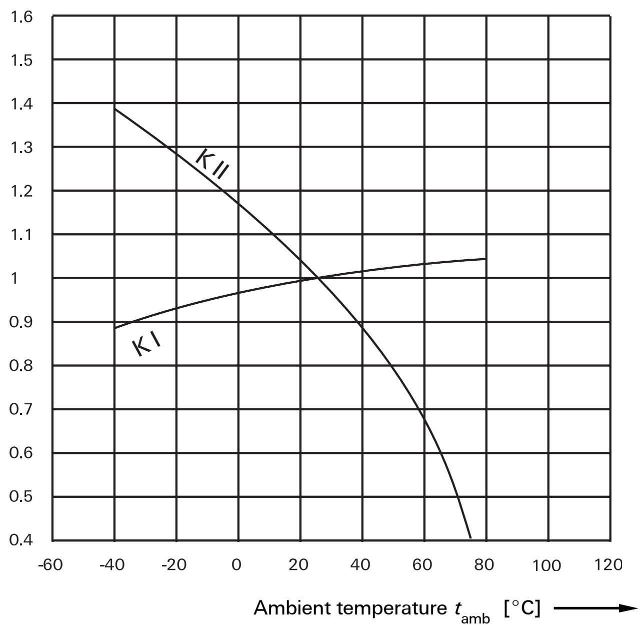
$U_{II\,tamb} = K_{II} \cdot U_{II\ 23°C}$

t_{amb} = Ambient temperature

$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}

$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}

k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Number of contacts and type	1 changeover contact
Contact assembly	Bifurcated contact
Contact material	Palladium nickel, gold-rhodium covered
Limiting continuous current at max. ambient temperature	1 A
Maximum switching current	1 A
Maximum swichting voltage	125 Vdc 150 Vac
Maximum switching capacity	30 W, 60 VA
Thermoelectric potential	< 100 μV
Initial contact resistance / measuring condition: 10 mA / 20 mV	< 50 mΩ
Electrical endurance at 12 V / 10 mA at 6 V / 100 mA at 30 V / 1000 mA	typ. 5 x 10^7 operations typ. 1 x 10^7 operations typ. 1 x 10^5 operations
Mechanical endurance	typ. 10^9 operations
UL/CSA ratings	30 Vdc / 1 A 65 Vdc / 0.46 A 150 Vac / 0.46 A

Insulation

Insulation resistance at 500 VDC	> 10^9 Ω
Dielectric test voltage (1 min) between coil and contacts (Relay with 1 coil) between open contacts	 1500 Vrms 500 Vrms
Surge voltage resistance according to Bellcore TR-NWT-001089 (2 / 10 μs) between coil and contacts (Relay with 1 coil) between open contacts according to FCC 68 (10 / 160 μs) between coil and contacts (Relay with 1 coil) between open contacts	 2500 V on request 2000 V 1500 V on request 1500 V
Insulation according to IEC / EN 60950 Clearance Creepage distance	Basic insulation 0.75 mm 0.75 mm

High Frequency Data

Capacitance between coil and contacts between open contacts	 max. 6 pF max. 5 pF
RF Characteristics Isolation at 100 / 900 MHz Insertion loss at 100 / 900 MHz V.S.W.R. at 100 / 900 MHz	 - 30.0 dB / - 18.0 dB - 0.12 dB / - 1.9 dB 1.06 / 1.75

General data

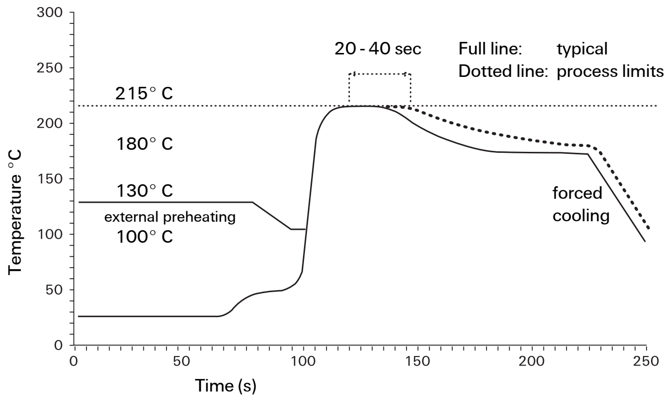
Operate time at U_{nom} typ. / max.	1 ms / 2 ms
Reset time (latching) at U_{nom} , typ. / max.	1 ms / 2 ms
Release time without diode in parallel (non-latching), typ. / max.	0.4 ms / 1 ms
Release time with diode in parallel (non-latching), typ. / max.	1.2 ms / 2 ms
Bounce time at closing contact, typ. / max.	1 ms / 3 ms
Maximum switching rate without load	200 operations/s
Ambient temperature	-40° C ... +70° C, +85° C on request
Thermal resistance	< 130 K/W
Maximum permissible coil temperature	85° C
Vibration resistance (function)	20 G, 200 to 2000 Hz 40 G, 10 to 200 Hz
Shock resistance, half sinus, 11 ms	50 G (function)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 20 s, burning time < 15 s
Mounting position	any
Processing information	Ultrasonic cleaning possible
Weight (mass)	max. 2 g
Resistance to soldering heat	260° C / 10 s

All data refers to 23° C unless otherwise specified.

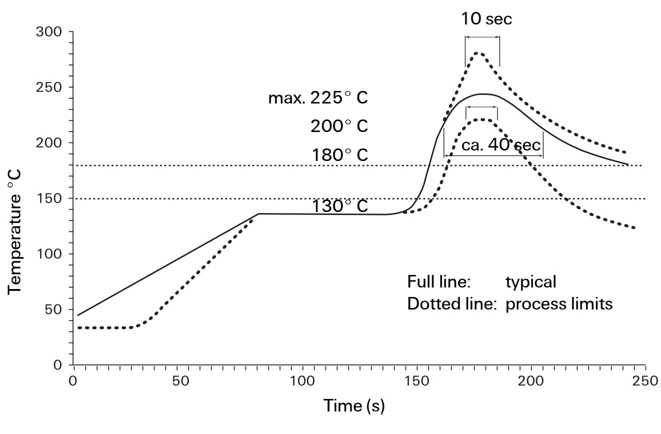
Recommended soldering conditions

Soldering conditions according CECC 00802

Note: Internal relay termperature should not exceed 210° C



Vapor Phase Soldering: Temperature/Time Profile
(Lead Temperature)

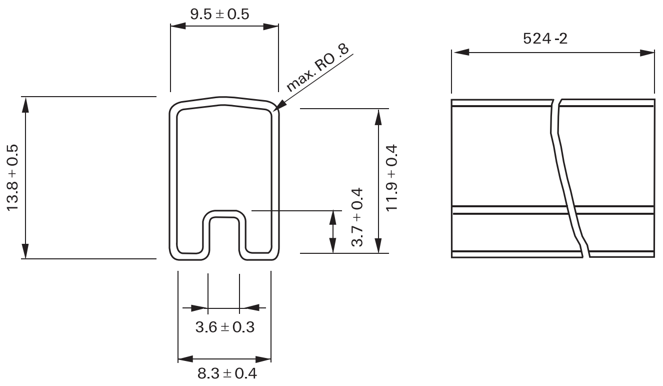


Infrared Soldering: Temperature/Time Profile
(Lead Temperature)

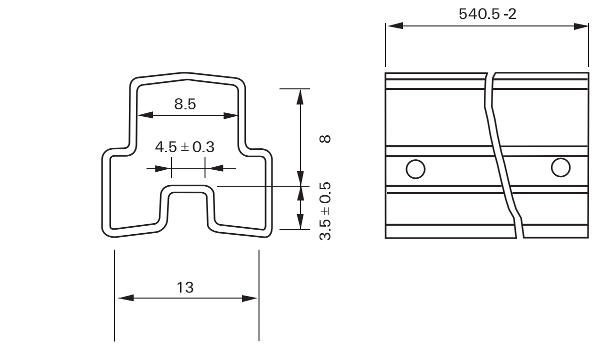
Packing

Dimensions in mm

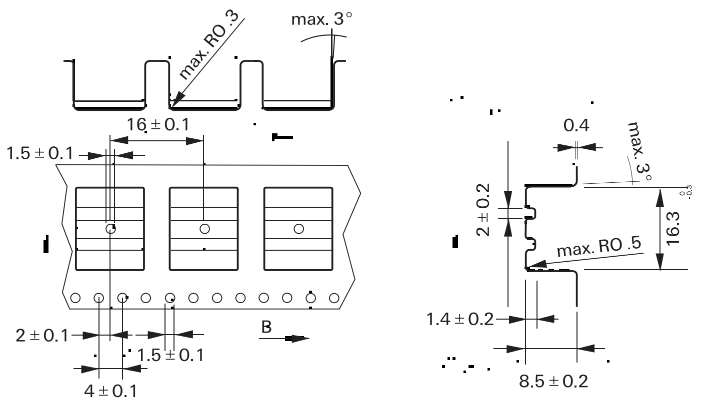
Tube for THT version - 40 relays per tube, 2000 relays per box



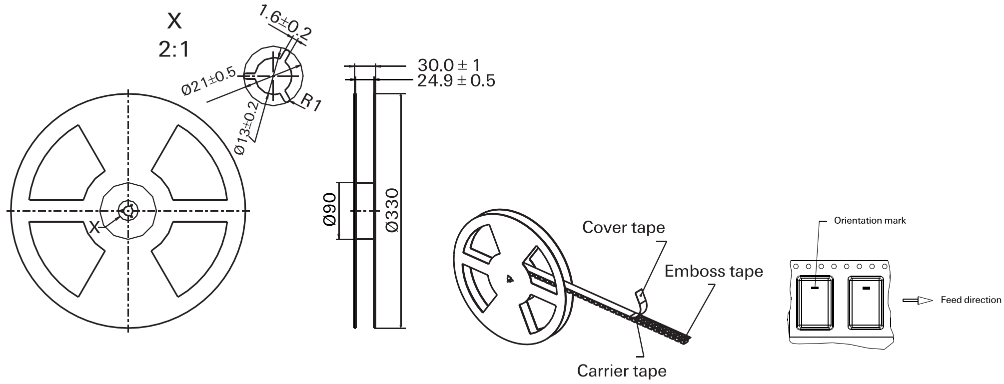
Tube for SMT version - 40 relays per tube 2000 relays per box



Tape and reel for SMT version - 480 relays per reel



Reel dimension



Ordering Information

Relay Code Tube packing	Tyco Part Number	Relay Code Tube packing	Tyco Part Number
V23026A1001B201	0-1393774-1	V23026D1021B201	3-1393774-7
V23026A1002B201	0-1393774-8	V23026D1022B201	3-1393774-8
V23026A1004B201	1-1393774-2	V23026D1024B201	3-1393774-9
V23026A1006B201	1-1393774-7	V23026D1026B201	2-1393774-9
V23026B1101B201	3-1393774-4	V23026E1101B201	4-1393774-1
V23026B1102B201	3-1393774-5	V23026E1102B201	4-1393774-2
V23026B1106B201	0-1393775-3	V23026E1106B201	0-1393777-3
V23026C1051B201	2-1393774-0	V23026F1051B201	1-1393776-0
V23026C1052B201	2-1393774-1	V23026F1052B201	4-1393774-3
V23026C1054B201	2-1393774-4		
V23026C1056B201	2-1393774-6		

Tape & reel packing

V23026D1021B201	0-1393776-3
V23026D1022B201	0-1393776-4
V23026D1024B201	0-1393776-7
V23026D1026B201	0-1393776-8
V23026E1101B201	0-1422015-6
V23026E1102B201	0-1393776-9

Middle block of relay code

V23026-xxyyy-B301
xx : See table below
yyy : See coil table on page 4

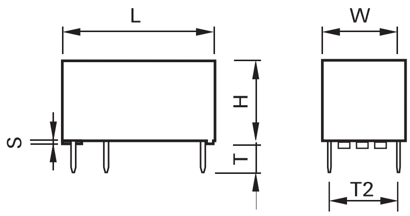
xx	Description
A1	THT, non latching
B1	THT, latching, 2 coils
C1	THT, latching, 1 coil
D1	SMT, non latching
E1	SMT, latching, 2 coils
F1	SMT, latching, 1 coil

Option: asymmetrical coil pinning

This supplementary data sheet refers to the basic data sheet of the P1 relay series (V23026) with following additions:

- Coil terminals are placed asymmetrically between contact terminals
- Only non latching, through hole types available
- All technical data are equivalent to the standard versions

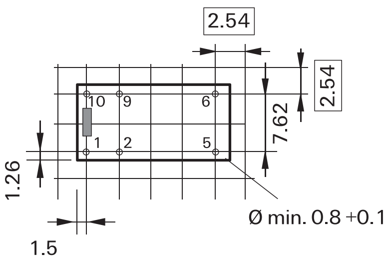
Dimensions



	V23026-A2xxx-B201 mm	inch
L	13.0 ± 0.1	0.512 ± 0.004
W	7.6 ± 0.1	0.299 ± 0.004
H	6.9 - 0.2	0.272 - 0.008
T	3.5 - 0.2	0.138 -0.008
T2	5.08 ± 0.15	0.200 ± 0.006
S	0.3 ± 0.1	0.012 ±0.004

Mounting hole layout

View onto the component side of the PCB

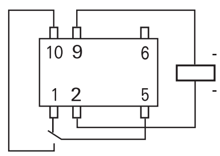


Terminal assignment

Relay - top view

Contact release condition, coil polarity to set the relay

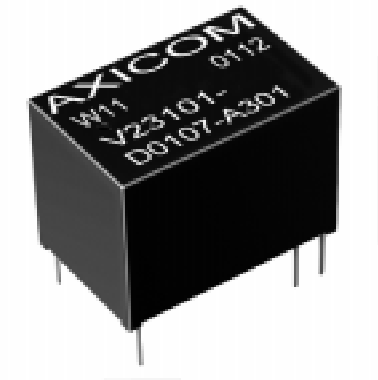
Non-latching type,
not energized condition



Coil Data (values at 23°C)

Nominal voltage Unom	Operate/set voltage range Minimum voltage U_I	Maximum voltage U_{II}	Release/ reset voltage Minimum	Nominal power consumption	Resistance	Coil number
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	
non-latching, 1 coil						V23026-A2xxx-B201
1.5	1.13	4.5	0.15	65	36	007
3	2.25	8.80	0.30	65	137	006
5	3.75	14.50	0.50	65	370	001
9	6.75	25.5	0.90	65	1165	005
12	9.00	35.00	1.20	65	2250	002
15	11.25	42.00	1.50	65	3100	003
24	18.00	50.00	2.40	130	4500	004

1 pole PCB relay, non-polarized,
Through Hole Type (THT)



Relay types: Non-latching, 1 coil
Terminal assignments symmetrical or assymetrical
5- or 6-pin version

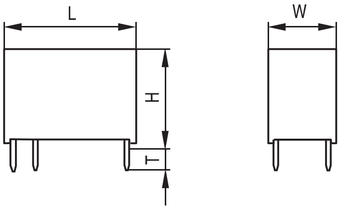
Features

- Multi purpose relay
- Small size permitting high packing density
- 1 changeover contact (1 form C / SPDT)
- 200 mW and 450 mW coils
- 1 A and 3 A contacts
- High shock resistance of 30 g
- Ambient temperature for sensitive version up to 85°C
- Immersion cleanable

Typical applications

- Security devices
- Electric door openers
- Duplex intercommunication systems
- Measurement and controls

Dimension drawing (in mm)

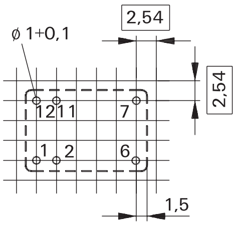


	V23101-Dxxx-Xxxx mm	inch
L	15.5 ± 0.1	0.610 ± 0.004
W	10.5 ± 0.1	0.413 ± 0.004
H	11.5 - 0.2	0.453 - 0.008
T	3.5 - 0.2	0.138 - 0.008

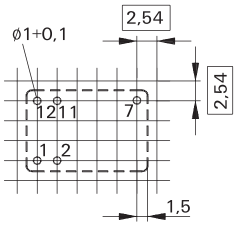
Mounting hole layout

View on to the component side of the PCB

Version: 6 pins



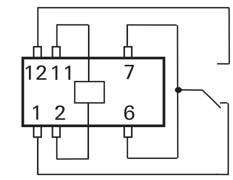
Version: 5 pins (without pin no. 6)



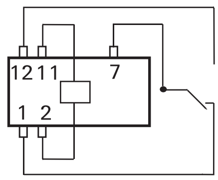
Terminal assignment

Relay - top view

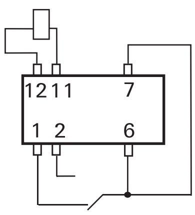
6 pin version with symmetrical coil assignment
V23101-D0 x x x -A x x x



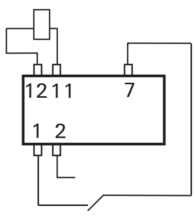
5 pin version with symmetrical coil assignment
V23101-D1 x x x -A x x x



6 pin version with asymmetrical coil assignment
V23101-D0 x x x -B x x x



5 pin version with asymmetrical coil assignment
V23101-D1 x x x -B x x x



Coil Data (values at 23°C)

Nominal voltage *U*nom	Operate/set voltage range: Minimum voltage U_I	Maximum voltage U_{II}	Release/reset voltage Minimum	Nominal power consumption	Resistance	Coil number
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %	

450 mW nominal power consumption

1.5	1.3	2.6	0.15	375	6	001
3	2.1	4.7	0.30	450	20	002
5	3.5	7.9	0.50	446	56	003
6	4.2	9.5	0.60	450	80	004
9	6.3	14.2	0.90	450	180	005
12	8.4	19.0	1.20	450	320	006
24	16.8	38.0	2.40	450	1280	007

200 mW nominal power consumption

1.5	1.1	3.6	0.15	188	12	101
3	2.3	7.1	0.30	200	45	102
5	3.8	11.6	0.50	208	120	103
6	4.5	14.2	0.60	200	180	104
9	6.8	21.2	0.90	203	400	105
12	9.0	28.0	1.20	206	700	106
24	18.0	56.0	2.40	206	2800	107

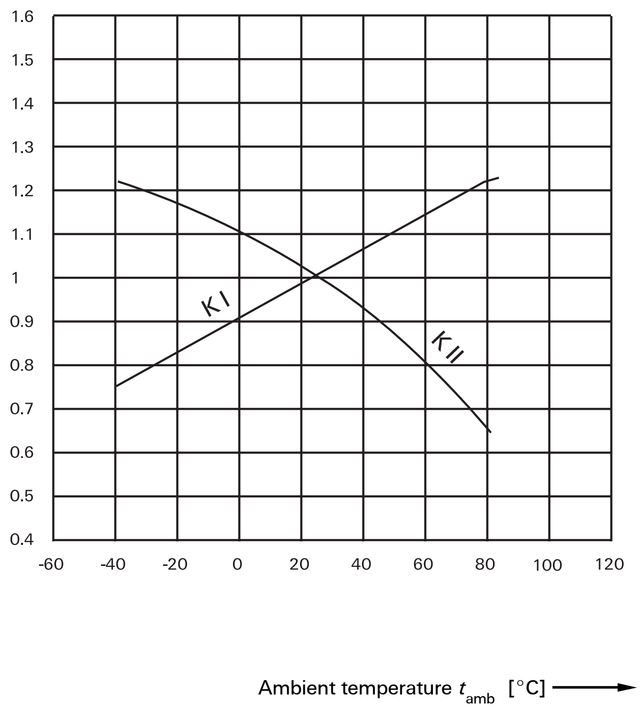
U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current

U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\ tamb}$ = $K_I \cdot U_{I\ 23°C}$
and
$U_{II\ tamb}$ = $K_{II} \cdot U_{II\ 23°C}$

t_{amb} = Ambient temperature
$U_{I\ tamb}$ = Minimum voltage at ambient temperature, t_{amb}
$U_{II\ tamb}$ = Maximum voltage at ambient temperature, t_{amb}
k_I, k_{II} = Factors (dependent on temperature), see diagram



Contact Data

Number of contacts and type	1 changeover contact	
Contact assembly	single contacts	
Contact material	AgPd, gold plated	AgNi
Limiting continuous current at max. ambient temperature	1 A	3 A
Maximum switching current	1.25	3 A
Maximum swichting voltage	60 Vdc 125 Vac	60 Vdc 125 Vac
Maximum switching capacity	30 W / 62.5 VA	72 W / 360 VA
Thermoelectric potential	< 10 μV	< 10 μV
Initial contact resistance / measuring condition: 10 mA / 20 mV	100 mΩ	100 mΩ
Electrical endurance		
standard: at 24 Vdc / 1 A	3 x 10^5	
at 24 Vdc / 2.5 A		2 x 10^5
at 120 Vac / 0.5 A	1.5 x 10^5	
at 120 Vac / 1 A		4 x 10^5
sensitive: at 24 Vdc / 1 A	2 x 10^5	
at 24 Vdc / 2.5 A		1 x 10^5
at 120 Vac / 0.5 A	1 x 10^5	
at 120 Vac / 1 A		3 x 10^5
Mechanical endurance	typ. 10^7 operations	

Insulation

Insulation resistance at 500 VDC	> 10^9 Ω
Dielectric test voltage (1 min)	
between coil and contacts	1000 Vrms
between open contacts	750 Vrms

High Frequency Data

Capacitance	
between coil and contacts	max. 10 pF
between open contacts	max. 2 pF

General data

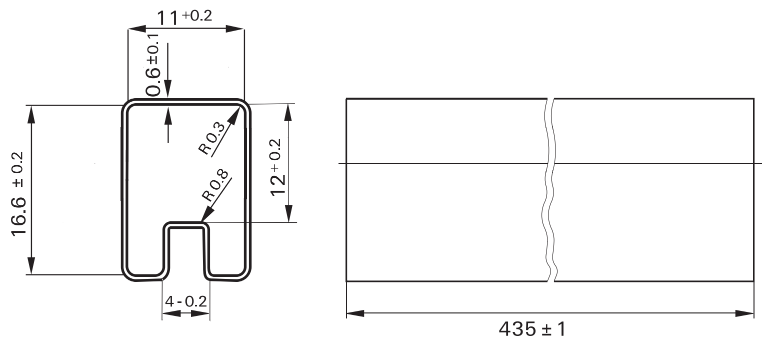
Operate time at U_{nom} typ. / max.	5 ms / 7 ms
Release time without diode in parallel, typ. / max.	3 ms / 5 ms
Release time with diode in parallel, typ. / max.	10 ms / 12 ms
Bounce time at closing contact, typ. / max.	1 ms / 2 ms NO contact 5 ms / 10 ms at NC conctact
Maximum switching rate without load	20 operations/s
Ambient temperature	-40° C ... +70° C/85° C, standard / sensitive coil
Thermal resistance	< 125 K/W
Maximum permissible coil temperature	130° C
Vibration resistance (function)	10 G, 10 to 200 Hz
Shock resistance, half sinus, 11 ms	30 G (function) 100 G (damage)
Degree of protection	immersion cleanable, IP 67
Needle flame test	application time 20 s, burning time < 15 s
Mounting position	any
Processing information	Ultrasonic cleaning is not recommended
Weight (mass)	max. 4 g
Resistance to soldering heat	260° C / 10 s

All data refers to 23° C unless otherwise specified.

Packing

Dimensions in mm

Tube dimensions - 25 relays per tube, 625 relays per box



Ordering Information

Relay Code	Tyco Part Number	Relay Code	Tyco Part Number
V23101D0001A201	0-1393779-1	V23101D0103B201	2-1393779-7
V23101D0001B201	0-1393779-2	V23101D0104A201	2-1393779-8
V23101D0002A201	0-1393779-3	V23101D0104B201	2-1393779-9
V23101D0002B201	0-1393779-4	V23101D0105A201	3-1393779-0
V23101D0003A201	0-1393779-5	V23101D0105B201	3-1393779-1
V23101D0003B201	0-1393779-6	V23101D0106A201	3-1393779-2
V23101D0003B301	0-1393779-7	V23101D0106A301	0-1422037-2
V23101D0004A201	0-1393779-8	V23101D0106B201	3-1393779-3
V23101D0004B201	1-1393779-0	V23101D0106B301	3-1393779-4
V23101D0005A201	1-1393779-1	V23101D0107A201	3-1393779-5
V23101D0005B201	1-1393779-2	V23101D0107A301	3-1393779-7
V23101D0006A201	1-1393779-3	V23101D0107B201	3-1393779-8
V23101D0006A301	4-1419172-4	V23101D0108A201	3-1393779-9
V23101D0006B201	1-1393779-6	V23101D1003B201	4-1393779-0
V23101D0006B301	1-1393779-7	V23101D1006A201	4-1393779-1
V23101D0007A201	1-1393779-8	V23101D1006B201	4-1393779-2
V23101D0007B201	2-1393779-0	V23101D1007B201	0-1413012-1
V23101D0007B301	2-1393779-1	V23101D1106A201	4-1393779-3
V23101D0101A201	2-1393779-2	V23101D1106B201	4-1393779-4
V23101D0101B201	2-1393779-3	V23101D1106B301	4-1393779-5
V23101D0102A201	2-1393779-4	V23101D1107A201	4-1393779-6
V23101D0102B201	2-1393779-5	V23101D1107B201	4-1393779-7
V23101D0103A201	2-1393779-6		

Relay code:

V23101-Dwxxx-yzzz

w :	0	Standard 6 pins
	1	5 pins version
xxx :		See coil table on page 4
y:	A	Symmetrical coil assignment, see page 3
	B	Asymmetrical coil assignment, see page 3
zzz:	201	AgPd contacts
	301	AgNi contacts

1 and 2 pole relays
non-polarized, non-latching

Features

- Direct coil control with TTL-signals possible
- Highly reliable switching
- High switching rates
- Ultrasonic cleanable
- High vibration and shock resistance

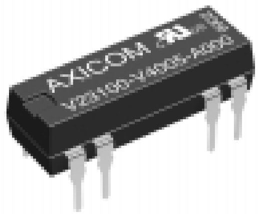
Typical applications

- Incircuit tester
- Measuring and control systems
- Telecom equipment
- Alarm and security equipment

E 48393

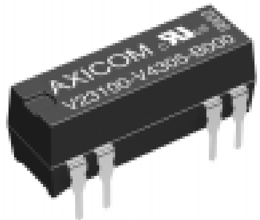
Relay Types

DIP version (flat)



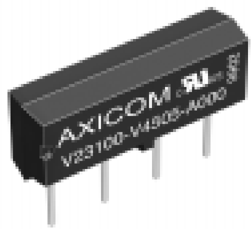
- Standard version
- Electrostatic shield between coil and contact
- Protective diode
- Electrostatic shield and protective diode
- Contact arrangement: 1 form a (1 normally open contact) or 1 form c (1 changeover contact)

DIP version (high)



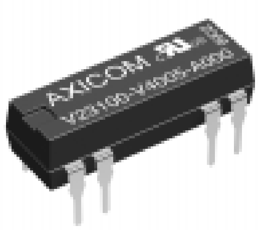
- Standard version
- Electrostatic shield between coil and contact
- Protective diode
- Electrostatic shield and protective diode
- Contact arrangement: 2 form a (2 normally open contacts) or 1 form c (1 changeover contact)

SIL version

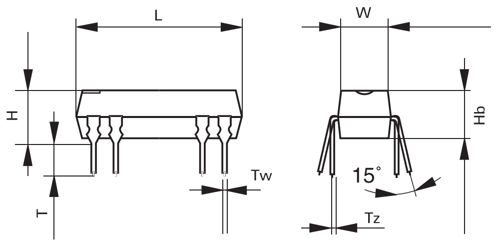


- Standard version
- Protective diode
- Electrostatic shield and protective diode
- Contact arrangement: 1 form a (1 normally open contact)

DIP version (flat)



Dimensions drawing (in mm)

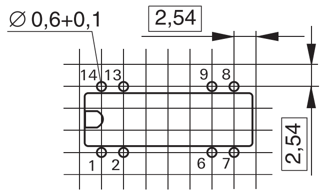


Dimensions

	DIP-flat version	
	mm	inch
L	19.3 - 0.2	0.760 - 0.008
W	6.40 - 0.2	0.252 - 0.008
H	5.70 - 0.2	0.224 - 0.008
Hb	5.10 - 0.2	0.201 - 0.008
T	3.20 ± 0.1	0.126 ± 0.004
Tw	0.50 ± 0.1	0.020 ± 0.004
Tz	0.25 ± 0.1	0.010 ± 0.004

Mounting hole layout

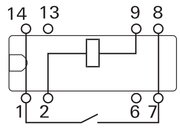
Top view



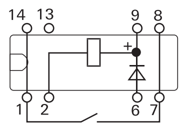
Terminal assignment

Relay - top view

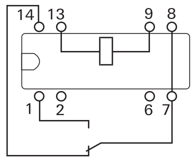
1 form a, standard



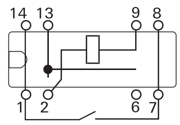
1 form a, with diode



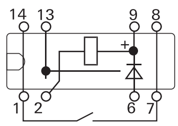
1 form c, standard

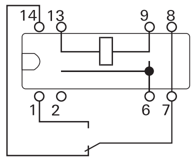


1 form a, with electrostatic shield



1 form a, with electrostatic shield and diode



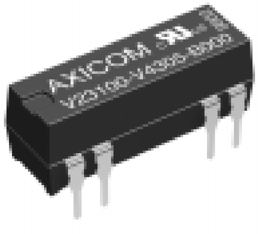


Ordering Information

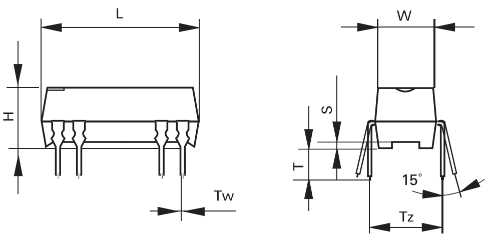
1 form a, standard	V23100-V40** - A000	
1 form a, with electrostatic shield	V23100-V40** - A001	05 = 5 Vdc coil
1 form a, with diode	V23100-V40** - A010	12 = 12 Vdc coil
1 form a, with electrostatic shield and diode	V23100-V40** - A011	15 = 15 Vdc coil
1 form c, standard	V23100-V43** - C000	24 = 24 Vdc coil
1 form c, with electrostatic shield	V23100-V43** - C001	

Ordering Code	Tyco Part Number	Ordering Code	Tyco Part Number
V23100-V4005-A000	0-1393763-1	V23100-V4024-A000	1-1393763-4
V23100-V4005-A001	0-1393763-3	V23100-V4024-A001	1-1393763-5
V23100-V4005-A010	0-1393763-4	V23100-V4024-A010	1-1393763-6
V23100-V4005-A011	0-1393763-5	V23100-V4024-A011	1-1393763-7
V23100-V4012-A000	0-1393763-6	V23100-V4305-C000	2-1393763-0
V23100-V4012-A001	0-1393763-7	V23100-V4305-C001	2-1393763-1
V23100-V4012-A010	0-1393763-8	V23100-V4312-C000	2-1393763-8
V23100-V4012-A011	0-1393763-9	V23100-V4312-C001	2-1393763-9
V23100-V4015-A000	1-1393763-0	V23100-V4315-C000	3-1393763-4
V23100-V4015-A001	1-1393763-1	V23100-V4315-C001	3-1393763-5
V23100-V4015-A010	1-1393763-2	V23100-V4324-C000	4-1393763-0
V23100-V4015-A011	1-1393763-3	V23100-V4324-C001	4-1393763-1

DIP version (high)



Dimensions drawing (in mm)

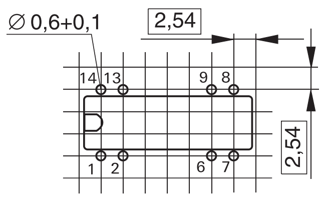


Dimensions

	DIP-flat version	
	mm	inch
L	19.3 - 0.2	0.760 - 0.008
W	7.00 - 0.2	0.276 - 0.008
H	7.50 - 0.2	0.295 - 0.008
S	0.50 ± 0.1	0.200 ± 0.004
T	3.20 ± 0.1	0.126 ± 0.004
Tw	0.50 ± 0.1	0.020 ± 0.004
Tz	0.25 ± 0.1	0.010 ± 0.004

Mounting hole layout

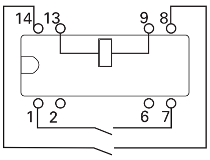
Top view



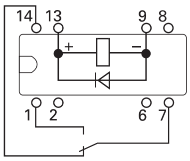
Terminal assignment

Top view

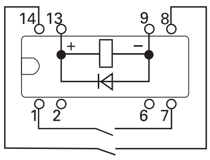
2 form a, standard



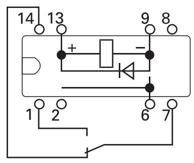
1 form c, with diode



2 form a, with diode



1 form c, with electrostatic shield and diode

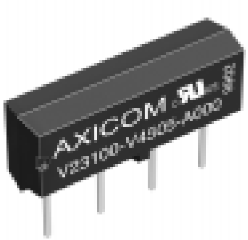


Ordering Information

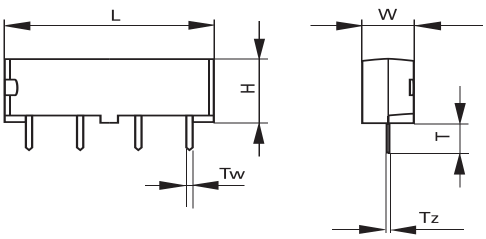
2 form a, standard	V23100-V43** - B000	05 = 5 Vdc coil
2 form a, with diode	V23100-V43** - B001	12 = 12 Vdc coil
1 form c, with diode	V23100-V43** - C010	15 = 15 Vdc coil
1 form c, with electrostatic shield and diode	V23100-V43** - C011	24 = 24 Vdc coil

Ordering Code	Tyco Part Number	Ordering Code	Tyco Part Number
V23100-V4305-B000	1-1393763-8	V23100-V4315-B000	3-1393763-2
V23100-V4305-B010	1-1393763-9	V23100-V4315-B010	3-1393763-3
V23100-V4305-C010	2-1393763-2	V23100-V4315-C010	3-1393763-6
V23100-V4305-C011	2-1393763-3	V23100-V4315-C011	3-1393763-7
V23100-V4312-B000	2-1393763-6	V23100-V4324-B000	3-1393763-8
V23100-V4312-B010	2-1393763-7	V23100-V4324-B010	3-1393763-9
V23100-V4312-C010	3-1393763-0	V23100-V4324-C010	4-1393763-2
V23100-V4312-C011	3-1393763-1	V23100-V4324-C011	4-1393763-3

SIL version



Dimensions drawing (in mm)

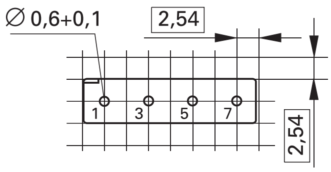


Dimensions

	DIP-flat version	
	mm	inch
L	19.8 - 0.2	0.780 - 0.008
W	5.08 - 0.2	0.200 - 0.008
H	7.80 - 0.2	0.307 - 0.008
T	3.50 ± 0.2	0.138 ± 0.008
Tw	0.60 ± 0.1	0.024 ± 0.004
Tz	0.25 ± 0.1	0.010 ± 0.004

Mounting hole layout

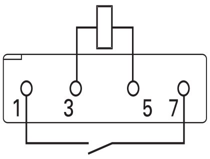
Top view



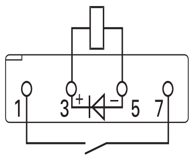
Terminal assignment

Top view

2 form a, standard



1 form a, with diode



Ordering Information

1 form a, standard V23100-V45** - A000
1 form a, with diode V23100-V45** - A010

Coil version: 05 = 5 Vdc coil
12 = 12 Vdc coil
15 = 15 Vdc coil
24 = 24 Vdc coil

Ordering Code	Tyco Part Number
V23100-V4505-A000	4-1393763-4
V23100-V4505-A010	4-1393763-5
V23100-V4512-A000	4-1393763-7
V23100-V4512-A010	4-1393763-8
V23100-V4515-A000	4-1393763-9
V23100-V4515-A010	5-1393763-0
V23100-V4524-A000	5-1393763-1
V23100-V4524-A010	5-1393763-2

Coil Data (values at 23°C)

Nominal voltage Unom	Operate/set voltage range		Release/ reset voltage Minimum	Nominal power consumption	Resistance
	Minimum voltage U_I	Maximum voltage U_{II}			
Vdc	Vdc	Vdc	Vdc	mW	Ω / ± 10 %

DIP and SIL version: 1 form a contact

5	3.5	22	0.75	50	500
12	8.4	33	1.80	144	1’000
15	10.5	44	2.25	112	2’000
24	16.8	44	3.60	288	2’000

DIP version: 2 form a contacts

5	3.5	14	0.75	125	200
12	8.4	25	1.80	288	500
15	10.5	47	2.25	112	2’000
24	16.8	47	3.60	288	2’000

DIP version: 1 form c contact

5	3.5	13 (14.5) *	0.75	125	200
12	8.4	22 (23.5) *	1.80	288	500
15	10.5	44 (14.5) *	2.25	112	2’000
24	16.8	44 (49) *	3.60	288	2’000

* Value in brackets refer to high relay with protective diode

U_I = Minimum voltage at 23° C after pre-energizing with nominal voltage without contact current

U_{II} = Maximum continous voltage at 23°

The operating voltage limits U_I and U_{II} depend on the temperature according to the formula:

$U_{I\,tamb} = K_I \cdot U_{I\,23°C}$

and

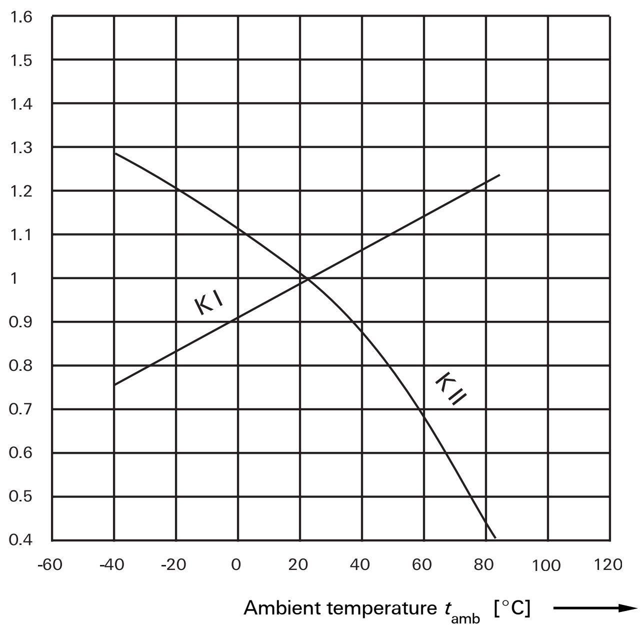
$U_{II\,tamb} = K_{II} \cdot U_{II\,23°C}$

t_{amb} = Ambient temperature

$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}

$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}

k_I, k_{II} = Factors (dependent on temperature), see diagram



General data

Type of relay	DIP version			SIL version
Type of contact/s	1 form a	2 form a	1 form c	1 form a
Maximum operate time (including bounce)	0.5 ms		0.7 ms	0.5 ms
Maximum release time (including bounce)	0.2 ms		1.0 ms	0.2 ms
Maximum switching load without load	650 operations/s	500 operations/s	150 operations/s	650 operations/s
Operating temperature range	-40° ...+70° C, + 85 ° C on request			
Storage temperature	-40 ° C ... + 95° C			
Thermal resistance	Approx. 75 K / W			
Maximum permissible coil temperature	105° C			
Vibration resistance (function)	10 G 10 to 2000 Hz		30 G 50 to 2000 Hz	10 G 10 to 2000 Hz
Shock resistance, half sinus, 11 ms	150 G		50 G	150 G
Degree of protection	immersion cleanable, IP 67			
Typical mechanical endurance	5 x 10 6 operations		4 x 10 6 operations	5 x 10 6 operations
Mounting position	any			
Resistance to soldering heat	10 s/ 260 ° C			

Contact data

Type of relay	DIP version			SIL version
Type of contact/s	1 form a	2 form a	1 form c	1 form a
Contact material	Gold covered with Rhodium			
Maximum continuous current	1 A		1.2 A	1 A
Maximum switching current	0.5 A		0.25 A	0.5 A
Maximum switching voltage at nominal voltage: 5 Vdc	180 Vdc / Vac		175 Vdc	180 Vdc / Vac
12-24 Vdc	200 Vdc / Vac			200 Vdc / Vac
Maximum switching capacity DC voltage	10 W		3 W	10 W
AC voltage	10 VA		3 VA	10 VA
Thermoelectric potential	< 100 μV			
Initial contact resistance / measuring condition:	<150 mΩ			
Electrical endurance 12 V / 10 mA	5×10^{7}			
24 V / 400 mA	5×10^{6}			
Mechanical endurance, typ.	5×10^{6} operations		4×10^{6} operations	5×10^{6} operations

Insulation

Insulation resistance at 500 VDC	contact coil > 10^{11} Ω		
Dielectric test voltage (1 min) contact / coil	1500 Vdc	1500 Vdc	1500 Vdc
contact / contact	250 Vdc	200 Vdc	250 Vdc

High Frequency Data

Capacitance	
between coil and contacts	max. 2 pF
between adjacent contact sets	max. 1 pF
between open contacts	max. 1 pF

PCB, hand solder or plug-in relays,
for DC operation,
non-polarized, non-latching

Features

- Multi purpose relay
- highly reliable
- great variety of contact arrangements and materials to meet specific applications
- Contacts for signal loads and currents up to 5 A
- AC and DC, latching and non-latching, coils operating voltage 1.5 V ... 125 V
- Sockets for easy and quick mounting of relays (see data sheet Accessories)

Typical applications

- Measurement and control equipment
- Press controls with high safety requirements (forcibly guided springs)
- Telecommunications

Versions

- Size I or II, depending on contact set
- Standard contact sets with max. 4 changeover, 2 break or 6 make contacts, special configurations on request
- Single or bifurcated contacts
- Hand solder terminals also for plug-in connection with screw fixing or PCB terminals
- Dust-protected with plastic cover, hermetically sealed with metal enclosure

Version V23154-Mxxxx Size I and
V23154-Nxxxx Size II

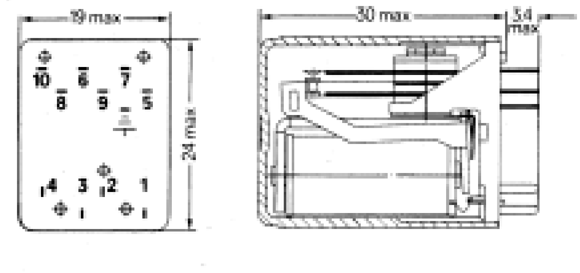
For printed circuit mounting

With or without earth terminal

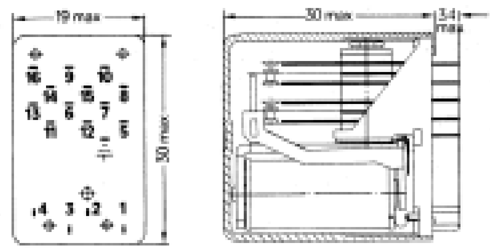
Dust-protected

Dimension drawing (in mm)

Size I

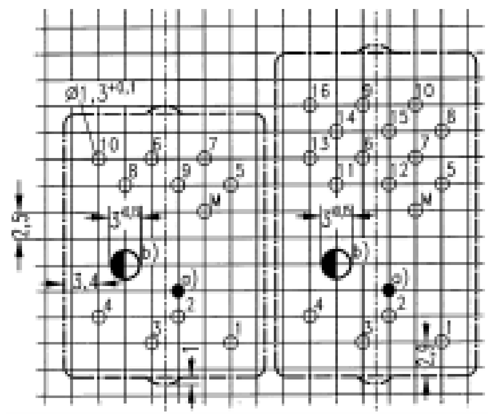


Size II



Mounting hole layout

View onto the component side of the PCB



M = Earth terminal

a) Hole for mechanical armature actuation, if required
b) Hole for socket mounting with screw M1.6,

Version V23154-C0xxx Size I and
V23154-D0xxx Size II

Hand solder terminals, silver-plated

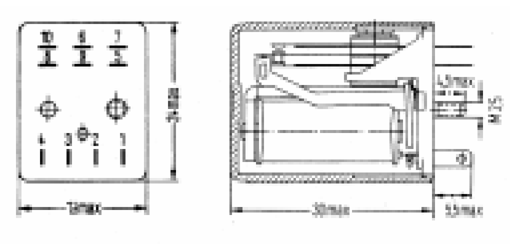
Also for plug-in connection
ans screw fixing

With earth terminal

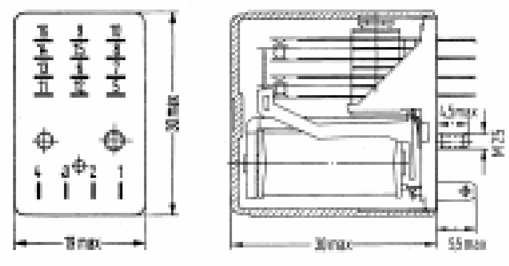
Dust-protected

Dimension drawing (in mm)

Size I

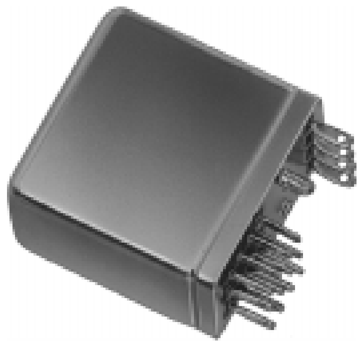


Size II



For sockets and hold-down springs see data sheet Accessories

Version V23162-A0xxx Size I and
V23162-B0xxx Size II



With hand solder terminals, silver-plated

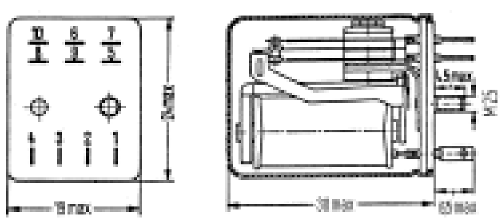
Also for plug-in connection
and screw fixing

With earth terminal

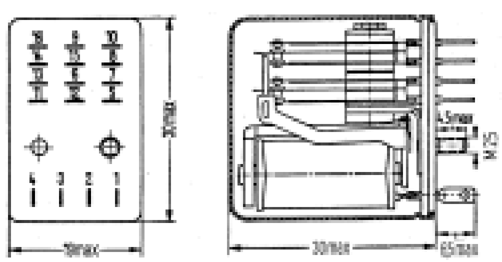
Hermetically sealed

Dimension drawing (in mm)

Size I



Size II



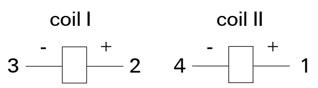
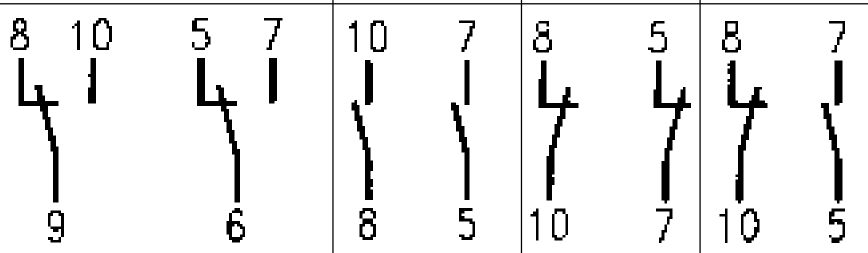
For sockets and hold-down springs see data sheet Accessories

Contact Data

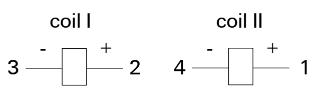
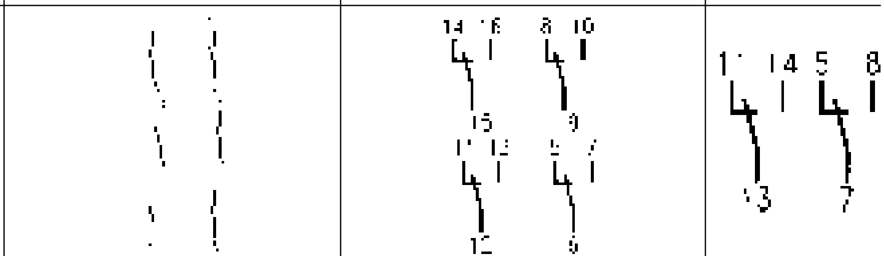
Ordering code block 3	B104/B110/ B112	B604/B610/ B612	C104/C110/ C112	C404/C410	F104 ... F107
Type of contact	max. 4 changeover contacts, 2 break contacts or 6 make contacts				
Contact assembly	single contacts		bifurcated contacts		single contacts
Contact material	silver, gold-flashed	gold F	silver, gold-flashed	gold F	silver, gold-flashed
Max. switching voltage	150 Vdc	36 Vdc	150 Vdc	36 Vdc	250 Vdc
	125 Vac	30 Vac	125 Vac	30 Vac	250 Vac
Max. switching current	2 A	0.2 A	2 A	0.2 A	5 A
Max. switching capacity	35 to 70 W see load limit curve page 7 50 VA	5 W 5 VA	35 to 70 W see load limit curve page 7 50 VA	5 W 5 VA	50 to 140 W see load limit curve page 7 500 VA
Max. continuous current at max. ambient temperature	2 A				5 A

Contact sets

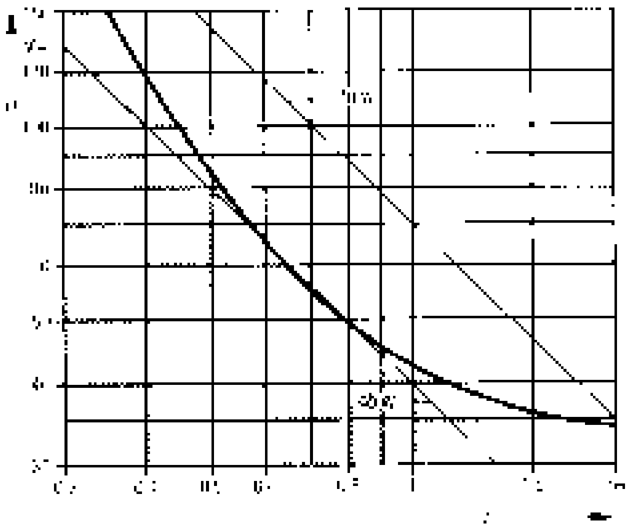
Size I

Number of contacts and type	2 changeover contacts		2 make contacts	2 break contacts	1 break 1 make contact
Symbols with base conncections  Contacts in release condition, coil polarity to set the relay					
Contact assembly	single contacts	bifurcated contacts	single contacts		
Contact material silver, gold-flashed Ordering code block 3	B104	C104	F105	F107	F106
Contact material gold F Ordering code block 3	B604	C404			

Size II

Number of contacts and type	6 make contacts		4 changeover		2 changeover
Symbols with base conncections  Contacts in release condition, coil polarity to set the relay					
Contact assembly	single contacts	bifurcated contacts	single contacts	bifurcated contacts	single contacts
Contact material silver, gold-flashed Ordering code block 3	B112	C112	B110	C 110	F 104
Contact material gold F Ordering code block 3	B612		B610	C 410	

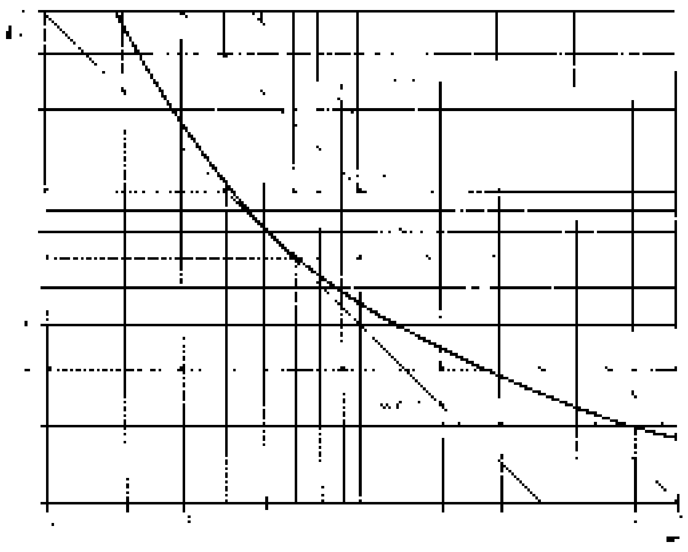
Load limit curve for contact sets B1xx and C1 xx



I = switching current
U = switching voltage

Safe breaking, no stationary arc
Contact material silver, gold-flashed

Load limit curve for contact sets F1xx



Safe breaking, no stationary arc
Contact material silver, gold-flashed

Coil Data

Nominal voltage	from 5 VDC to 125 VDC
Typical nominal power consumption, at 20˚C	0.8 W
Class of the operative range acc to EN 61810-1 / IEC 61810-1 and VDE 0435 Part 201	2
Operating voltage (according to the coil type)	max. 98% of the nominal voltage

Coil version

Nominal voltage U_{nom} Vdc	Operating voltage range at 20° C Minimum voltage U_I Vdc				Maximum voltage U_{II} Vdc	Resistance at 20° C Ω	Coil number Ordering code block 2
	Conctact sets -B104/-B604/ -F105	-B110/-B112/-B610/ -612/-C104/-C404/ -F104/-F106/-F107	-C112	-C110 -C410			
5	1.8	2.5	3	3.7	7.2	28 ± 3	711
12	5.3	7.1	8.7	10.5	20	220 ± 22	717
24	11	14.5	18	22	40	890 ± 89	721
48	23	30	37	45	75	3200 ± 480	726
60	27	36	43	53	92	4700 ± 705	734
110	49	65	79	98	164	15000 ± 1500	735
125	61	81	99	122	190	20900 ± 3140	703

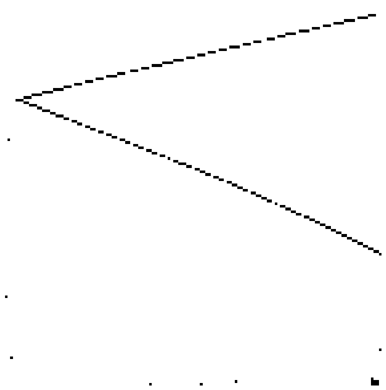
Terminals:
Coil with 1 winding
Start 4 End 1

Coil with 2 windings (upon request)
Start 3 End 2 for winding I
Start 4 End 1 for winding II

The minimum voltage U_I depends on the contact set and the ambient temperature, the maximum voltage U_{II} only depends on the ambient temperature.

Between minimum voltage $U_{I\,tamb}$ and operating voltage U a safety margin of approx. 20% is recommended.

$U_{I\,tamb}$ (1.2) $< U_I \leq U_{II\,tamb}$
$U_{I\,tamb}$ $= U_I \cdot U_{20°C} \cdot k_{I\,tamb}$
$U_{II\,tamb}$ $= U_{II\;20°C} \cdot k_{II\,tamb}$
t_{amb} = Ambient temperature
U = Operating voltage
$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}
$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}
k_I and k_{II} = Factors



Instructions for impulse operation

The maximum voltage stated in the table (page 8) can be increased for impulse operation as follows:

$U_{II\ Impuls}$ = $U_{II\ tamb} \cdot q$
$U_{II\ tamb}$ = Maximum continuous voltage at ambient temperature t_{amb}
q = Factor

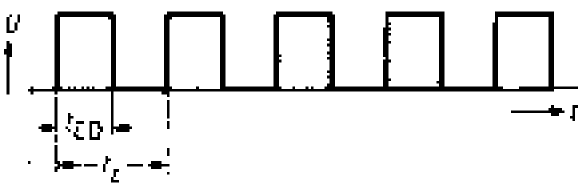
The impulse voltage must not exceed 80% of the test voltage (winding/frame or winding/winding) or 2.5 times the value of the maximum voltage listed in the table (page 8).

If $t_{ED} \leq 3$ s then $q = \sqrt{\frac{t_z}{t_{ED}}}$

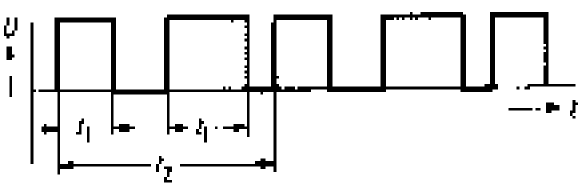
If t_{ED} = Pulse width
t_2 = Cycle time
If t_{ED} = > 3 s the value of q must be obtained from the nomograph (next page).

Examples of various periodic pulse trains (energizing side)

1. Periodic recurrence of one energizing pulse

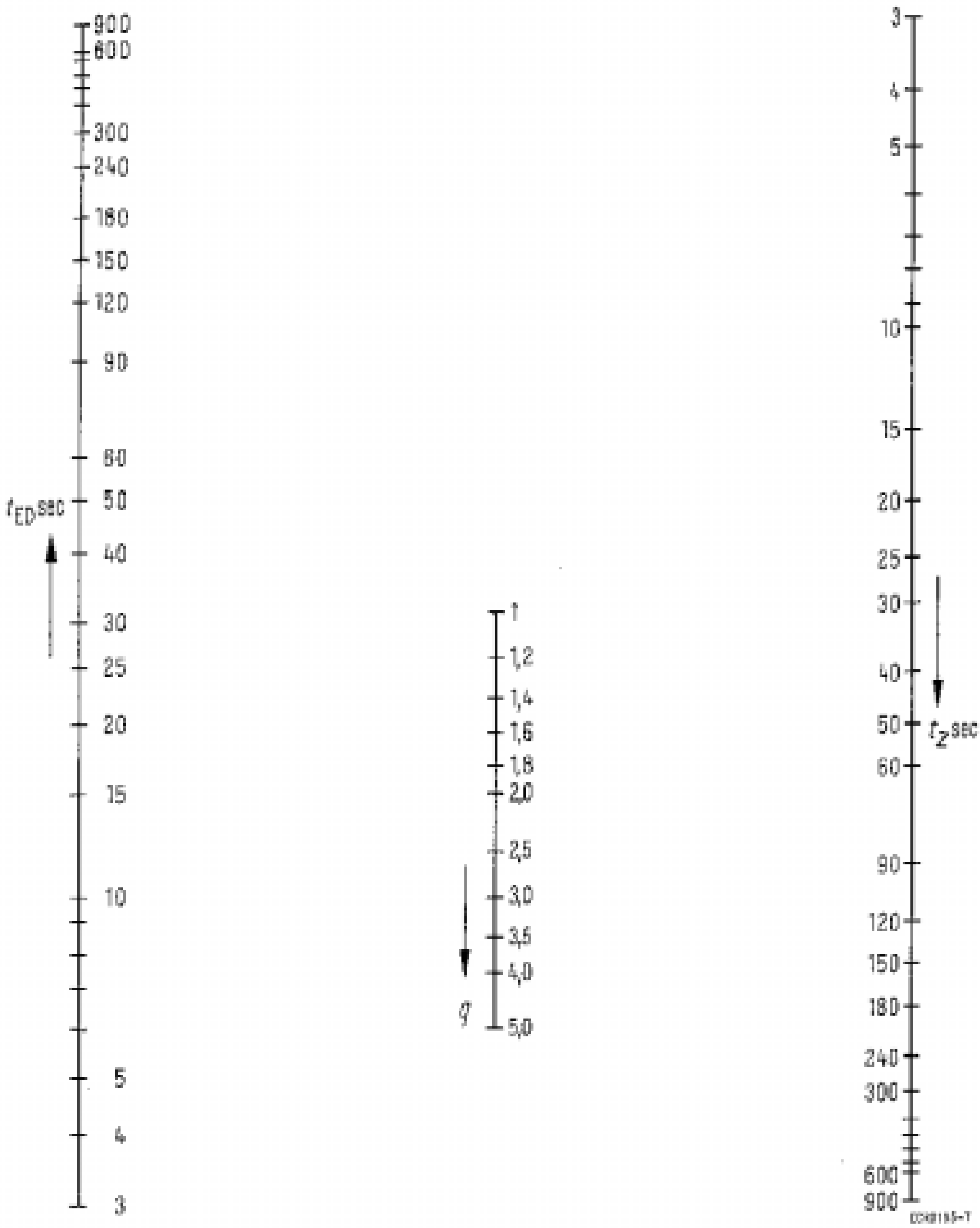


2. Periodic recurrence of two unequal energizing pulses



t_{ED} = $t_I + t_{II}$
$t_I + t_{II}$ = Pulse widths within one cycle

Nomograph for determining factor *q*



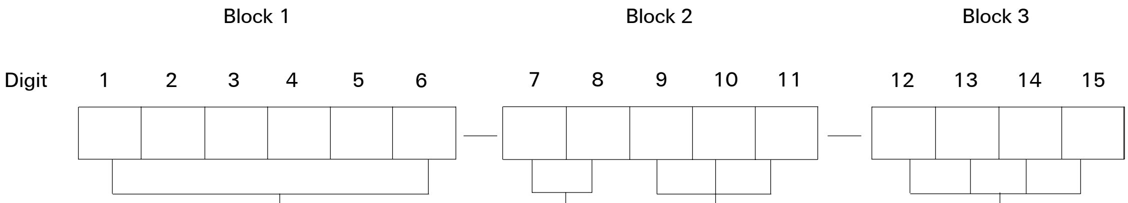
General data

Ordering code block 3	B1xx	B6xx	C1xx	C4xx	F1xx
Operate time at U_{nom} and 20° C, typical	7.5 ms				
Reset time typical	3 ms				
Maximum switching rate without load	50 operations/s				10 operations/s
Ambient temperature range acc. to EN 61810-1 / IEC 61810-1 and VDE 0435 part 201	-40° C ... +70° C				
Thermal resistance	50 K/W				
Maximum temperature	100° C				
Continious thermal load	1.6 W				
Degree of protection acc. to EN 60529 / IEC 60529 / VDE 0470 part 1	dust-protected IP 30 or hermetically sealed IP 67				
Mechanical endurance	approx. 10^8 operations				approx. 10^7 operations
Mounting position	any				
Processing information	Ultrasonic cleaning should be avoided if possible or carried out only after consulting the manufacturer				
Weight					
V23154-C0/-MO Size I	approx. 20 g				
V23154-D0/-NO Size II	approx. 25 g				
V23162-A0 Size I	approx. 30 g				
V23162-B0 Size II	approx. 35 g				

Insulation

Test voltage (1 min)		
winding / frame	500 Vac_{rms}	500 Vac_{rms}
contact / contact	500 Vac_{rms}	1000 Vac_{rms}
contact / frame	500 Vac_{rms}	1000 Vac_{rms}
contact / coil	1000 Vac_{rms}	1500 Vac_{rms}

Ordering Code



Basic type number of cradle relay N
V23154 = dust-protected
V23162 = hermetically sealed

Relay type
A0 = Size I,
for plug-in and screw fixing, hand solder terminals tinned,
with earth terminal, hermetically sealed
B0 = Size II,
for plug-in and screw fixing, hand solder terminals tinned,
with earth terminal, hermetically sealed
C0 = Size I,
for plug-in and screw fixing, hand solder terminals silver-plated,
with earth terminal, dust-protected
D0 = Size II,
for plug-in and screw fixing, hand solder terminals silver-plated,
with earth terminal, dust-protected
M0 = Size I,
for printed circuit mounting, with earth terminal, dust-protected
N0 = Size II,
for printed circuit mounting, with earth terminal, dust-protected
M4 = Size I,
for printed circuit mounting, without earth terminal, dust-protected
N4 = Size II,
for printed circuit mounting, without earth terminal, dust-protected

Coil number
Versions see page 8

Contact set / type of contact
see page 6

Ordering example:
V23154-D0721-B110
Cradle relay N, size II, plug-in, dust-protected, with solder terminals, silver-plated, coil 24 Vdc,
4 changeover contact set, single contacts, contact material silver, gold-flashed, with earth terminal,

Note:
The ordering scheme enables a multitude of variations. However, not all variations are defined as construction specifications (ordering code) and thus in the current delivery program.

Ordering Information

Relay Code	Tyco Part Number	Relay Code	Tyco Part Number
V23154C 702F101	3-1393806-3	V23154D 719B110	5-1393808-6
V23154C 704B104	4-1393806-3	V23154D 719F104	6-1393808-2
V23154C 716B104	6-1393806-4	V23154D 720B110	6-1393808-5
V23154C 717B104	6-1393806-7	V23154D 720C110	7-1393808-0
V23154C 719B104	7-1393806-1	V23154D 720C410	7-1393808-3
V23154C 720B104	7-1393806-8	V23154D 720F104	7-1393808-6
V23154C 720C104	8-1393806-1	V23154D 720W 56	7-1393808-8
V23154C 720F106	8-1393806-3	V23154D 721B110	8-1393808-3
V23154C 721B104	8-1393806-6	V23154D 721B112	8-1393808-4
V23154C 721B604	8-1393806-7	V23154D 721B610	9-1393808-2
V23154C 721C104	8-1393806-8	V23154D 721C110	9-1393808-5
V23154C 721F105	9-1393806-1	V23154D 721F104	0-1393809-1
V23154C 722B104	9-1393806-4	V23154D 722B110	1-1393809-4
V23154C 726B104	0-1393807-6	V23154D 722F104	2-1393809-4
V23154D 421B110	3-1393807-7	V23154D 726B110	3-1393809-2
V23154D 421F104	4-1393807-4	V23154D 726F104	4-1393809-4
V23154D 703F104	0-1393808-4	V23154M 721B104	2-1393810-7
V23154D 704B110	0-1393808-6	V23154N 719B110	6-1393810-3

Hand solder and plug-in relay,
for AC operation,
non-polarized, non-latching

Features

- highly reliable
- great variety of contact arrangements and materials to meet specific applications
- Contacts for signal loads and currents up to 5 A
- Sockets for easy and quick mounting of relays (see data sheet Accessories)

Typical applications

- Operation of the coil with alternating voltage
- Machine controls

Versions

- Size I or II, depending on height of the contact set
- Various contact arrangements available:
  max. 4. changeover contacts, 2 break contacts or 2 make contacts
- Single or bifurcated contacts
- Hand solder terminals, for plug-and-socket connection, screw fixing
- Dust-protected

Version V23005-A0xxx Size I and
V23005-B0xxx Size II

With hand solder terminals, silver-plated

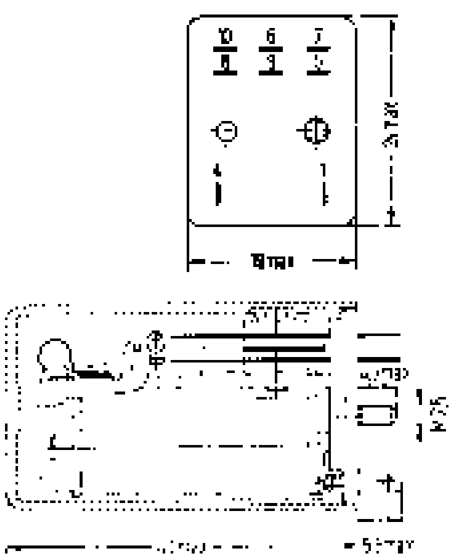
Also for plug-and-socket connection plus screw fixing

With earth terminal

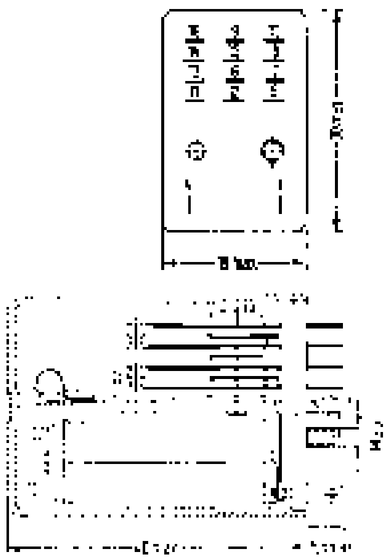
Dust-protected

Dimension drawing (in mm)

Size I



Size II

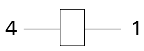
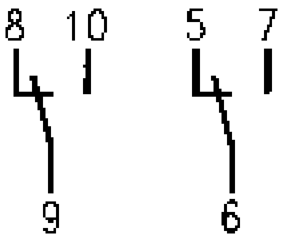
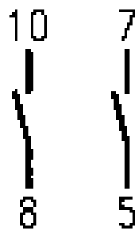
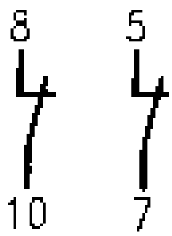
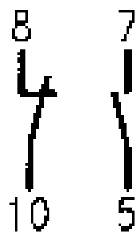


Contact Data

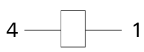
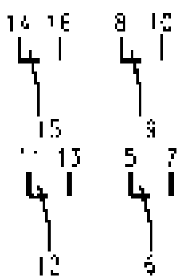
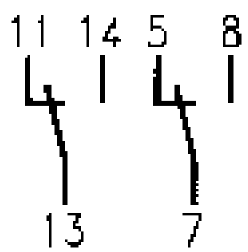
Ordering code block 3	B104/B110	B604/B610	C104/C110	C404/C410	F104 ... F107
Type of contact	max. 4 changeover contacts, 2 break contacts or 2 make contacts				
Contact assembly	single contacts		bifurcated contacts		single contacts
Contact material	silver, gold-flashed	gold F	silver, gold-flashed	gold F	silver, gold-flashed
Max. switching voltage	150 Vdc 125 Vac	36 Vdc 30 Vac	150 Vdc 125 Vac	36 Vdc 30 Vac	250 Vdc 250 Vac
Max. switching current	2 A	0.2 A	2 A	0.2 A	5 A
Max. switching capacity	35 to 70 W see load limit curve page 5 50 VA	5 W 5 VA	35 to 70 W see load limit curve page 5 50 VA	5 W 5 VA	50 to 140 W see load limit curve page 5 500 VA
Max. continuous current at max. ambient temperature	2 A				5 A

Contact sets

Size I

Number of contacts and type	2 changeover contacts		2 make contacts	2 break contacts	1 break 1 make contact
Symbols with base conncections 					
Contact assembly	single contacts	bifurcated contacts	single contacts		
Contact material silver, gold-flashed Ordering code block 3	B104	C104	F105	F107	F106
Contact material gold F Ordering code block 3	B604	C404			

Size II

Number of contacts and type	4 changeover contacts		2 changeover contacts
Symbols with base conncections 			
Contact assembly	single contacts	bifurcated contacts	single contacts
Contact material silver, gold-flashed Ordering code block 3	B110	C110	F 104
Contact material gold F Ordering code block 3	B610	C 410	

Coil Data

Nominal voltage	from 6 Vac to 220 Vac
Typical nominal power consumption, at 20˚C	1.15 W
Class of the operative range acc to EN 61810-1 / IEC 61810-1 and VDE 0435 Part 201	1
Operating voltage (according to the coil type)	max. 80% of the nominal voltage

Coil version

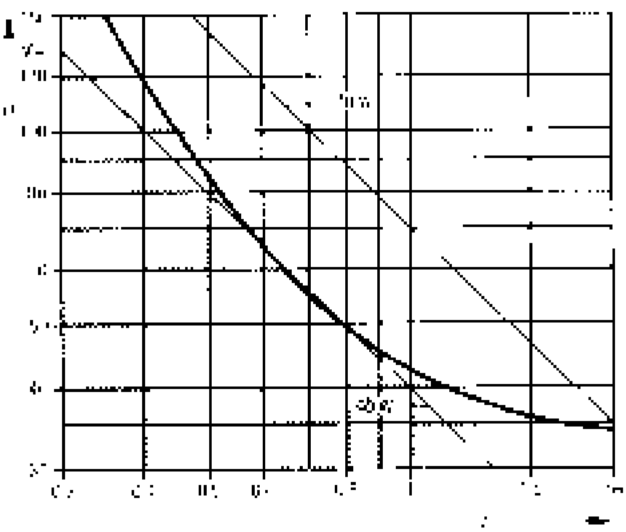
Nominal voltage U_{nom} Vac (50 Hz / 60 Hz)	DC resistance at 20° C Ω	Terminals Start	End	Coil number Ordering code block 2
6	8 ± 0.8	4	1	015
12	40 ± 4.0	4	1	017
24	170 ± 17	4	1	010
48	620 ± 62	4	1	019
60	1000 ± 100	4	1	008
110	3200 ± 480	4	1	007
220	14000 ± 2100	4	1	004

At 70° C ambient temperature the operating voltage is permitted to deviate from the rated values by + 10% and - 20%.

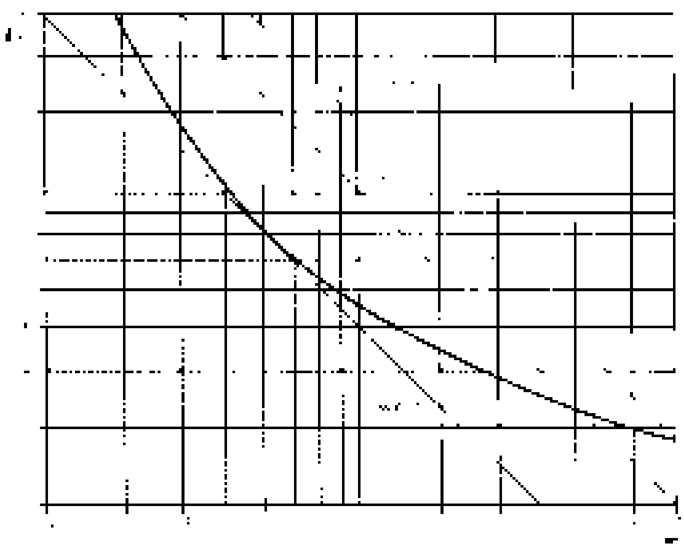
Load limit curve

Safe breaking, no stationary arc
Contact material silver, gold-flashed

Contact sets B1xx and C1xx



Contact sets F1xx



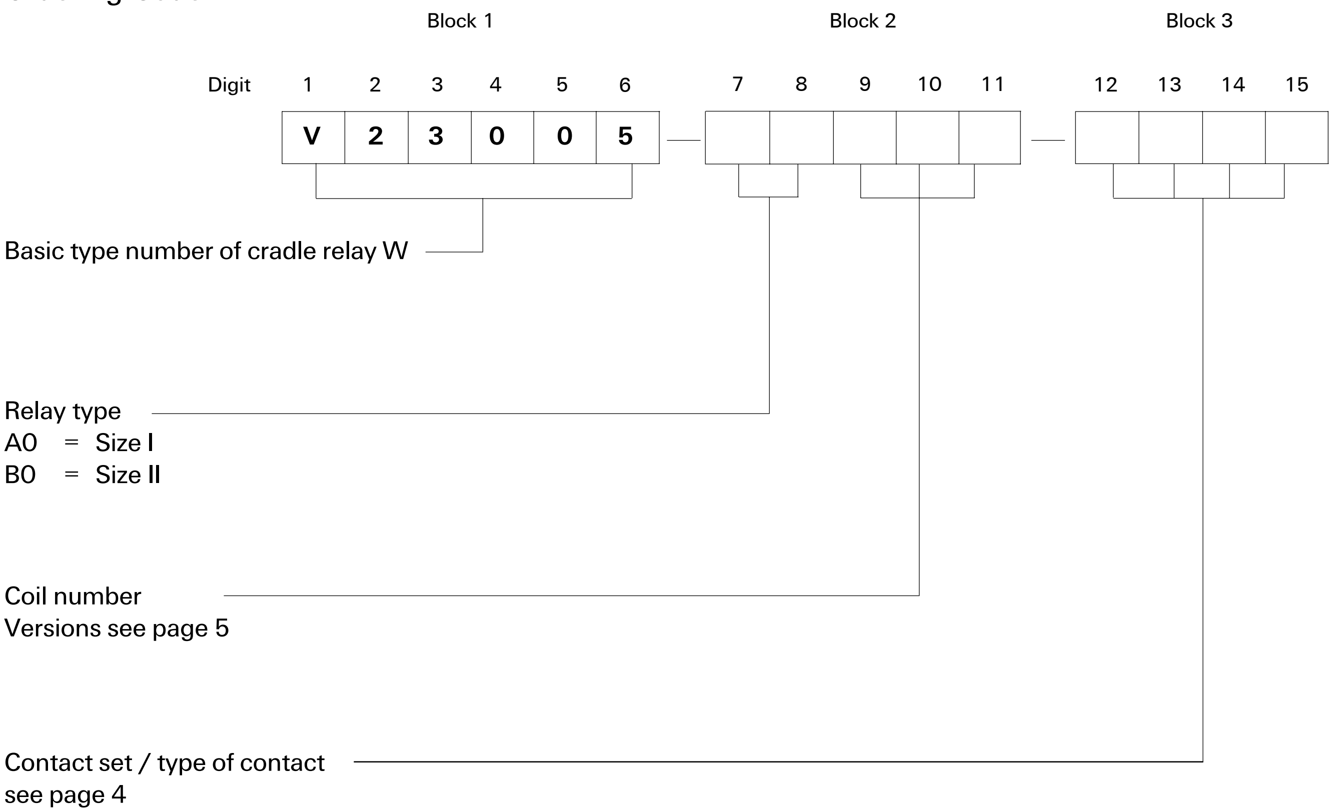
General data

Ordering code block 3	B1xx	B6xx	C1xx	C4xx	F1xx
Maximum switching rate without load	20 operations/s				
Ambient temperature range acc. to EN 61810-1 / IEC 61810-1 and VDE 0435 part 201	-40° C ... +70° C				
Thermal resistance	35 K/VA				
Maximum temperature	100° C				
Continious thermal load	2.2 VA				
Degree of protection acc. to EN 60529 / IEC 60529 / VDE 0470 part 1	dust-protected IP 40				
Mechanical endurance	approx. 10^7 operations				approx. 10^8 operations
Mounting position	any				
Weight Size I Size II	 approx. 35 g approx. 40 g				

Insulation

Ordering code block 3	B1xx	B6xx	C1xx	C4xx	F1xx
Test voltage (1 min)					
winding / frame	500 Vac_{rms} at nominal voltages ≤ 60 V 500 Vac_{rms} at nominal voltages > 60 V				
contact / contact	500 Vac_{rms}				1000 Vac_{rms}
contact / frame	1000 Vac_{rms}				1000 Vac_{rms}

Ordering Code



Ordering example:
V23005-B004-F104
Cradle relay W, size II, coil 220 Vac, 2 changeover contact set, single contacts, contact material silver, gold-flashed

Note:
The ordering scheme enables a multitude of variations. However, not all variations are defined as construction specifications (ordering code) and thus in the current delivery program.

Special design can be carried out to customer specifications. Please contact your local representative.

Ordering Information

Relay Code	Tyco Part Number
V23005A 4B104	0-1393816-1
V23005B 4B110	2-1393816-2
V23005B 4F104	2-1393816-8
V23005B 7B110	3-1393816-0
V23005B 10B110	4-1393816-0
V23005B 10F104	4-1393816-3

Hand solder and plug-in relay,
for DC operation,
non-polarized, non-latching

Features

- Stronger magnet system and thus wider voltage range than cradle relay N
- highly reliable
- Contacts for signal loads and currents up to 5 A
- AC and DC, latching and non-latching, coils operating voltage 6 V ... 220 V
- Multi purpose relay
- great variety of contact arrangements and materials to meet specific applications
- Sockets for easy and quick mounting of relays (see data sheet Accessories)

Typical applications

- Press controls with high safety requirements (forcibly guided springs)
- Traffic and railroad signalling engineering
- Motor vehicle traffic controls

Versions

- Size I, II or III, depending on contact set
- Standard contact sets with max. 6 changeover contacts or 6 make contacts
- Single or bifurcated contacts
- Hand solder terminals also for plug-in connection with screw fixing
- Dust-protected

Version V23054-Cxxx Size I and
V23054-Dxxx Size II

Hand solder terminals, silver-plated

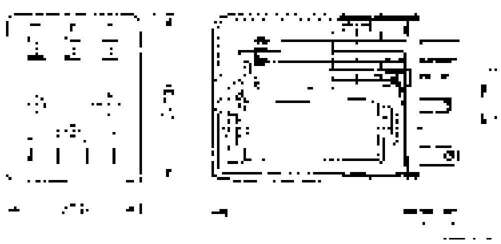
Also for plug-and-socket connection
plus screw fixing

With earth terminal

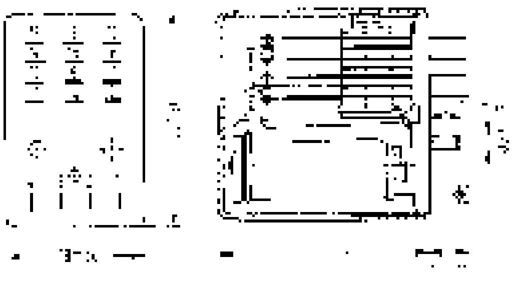
Dust-protected

Dimension drawing (in mm)

Size I



Size II



For sockets and hold-down springs see data sheet Accessories

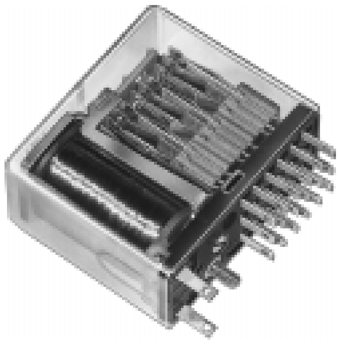
Version V23054-Exxx Size III

Hand solder terminals, silver-plated

Also for plug-in connection
plus screw fixing

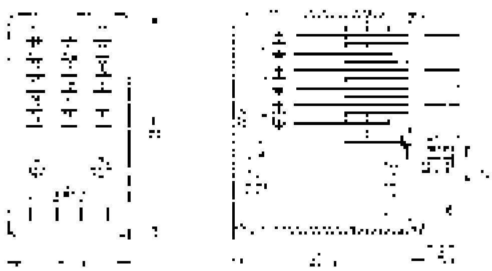
With earth terminal

Dust-protected



Dimension drawing (in mm)

Size III



For sockets and hold-down springs see data sheet Accessories

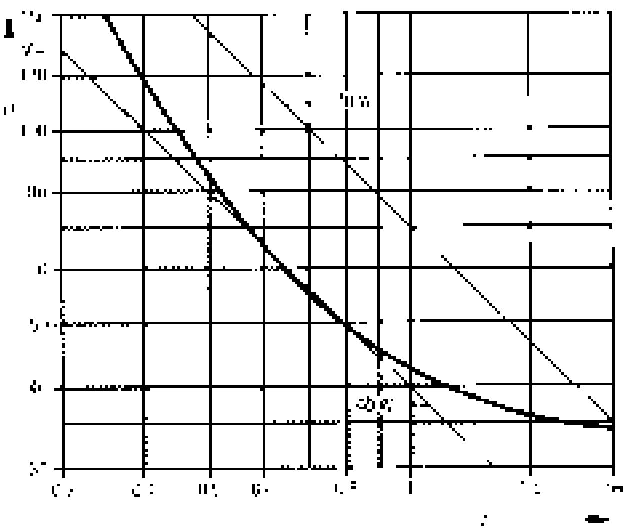
Contact Data

Ordering code block 3	B104/B110/ B112/B 133	B604/B610/ B612/B633	C104/C110/ C112/C133	C404/C410/ C412/C433	F104/F105/ F 110
Type of contact	max. 6 changeover contacts or 6 make contacts				
Contact assembly	single contacts		bifurcated contacts		single contacts
Contact material	silver, gold-flashed	gold F	silver, gold-flashed	gold F	silver, gold-flashed
Max. switching voltage	150 Vdc 125 Vac	36 Vdc 30 Vac	150 Vdc 125 Vac	36 Vdc 30 Vac	250 Vdc 250 Vac
Max. switching current	2 A	0.2 A	2 A	0.2 A	5 A
Max. switching capacity	35 to 70 W see load limit curve 50 VA	5 W 5 VA	35 to 70 W see load limit curve 50 VA	5 W 5 VA	50 to 140 W see load limit curve 500 VA
Max. continuous current at max. ambient temperature	2 A				5 A

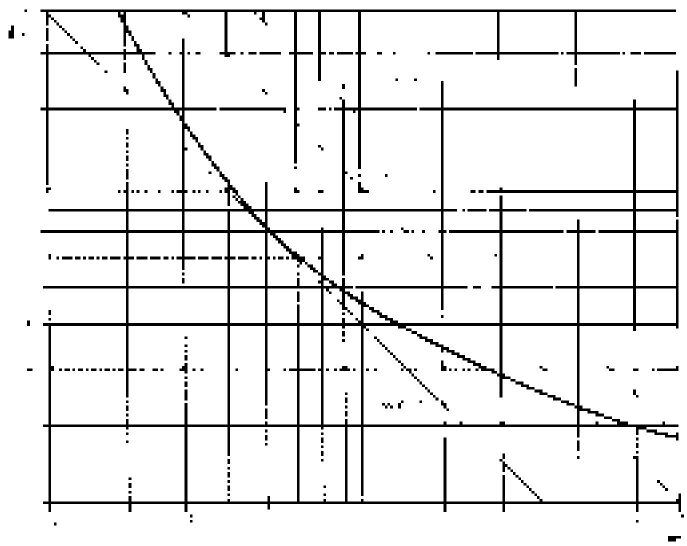
Load limit curve

Safe breaking, no stationary arc
Contact material silver, gold-flashed

Contact sets B1xx and C1xx

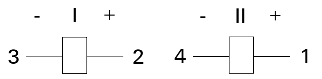
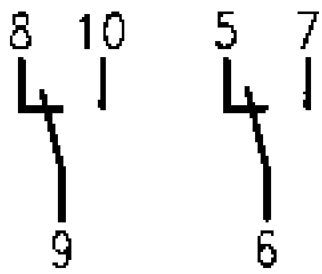
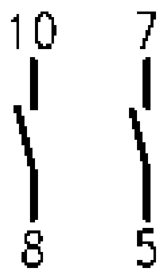


Contact sets F1xx

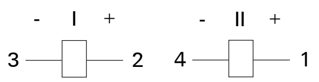
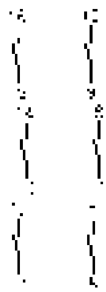
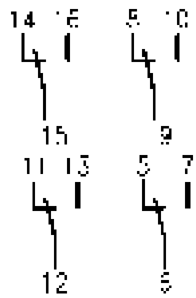
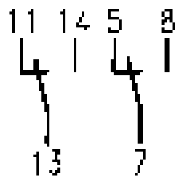


Contact sets

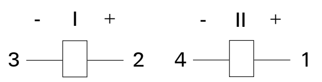
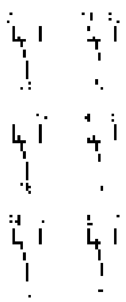
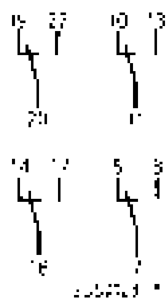
Size I

Number of contacts and type	2 changeover contacts		2 make contacts
Symbols with base conncections  Contacts in release condition, coil polarity to set the relay			
Contact assembly	single contacts	bifurcated contacts	single contacts
Contact material silver, gold-flashed Ordering code block 3	B104	C104	F105
Contact material gold F Ordering code block 3	B604	C404	

Size II

Number of contacts and type	6 make contacts		4 changeover contacts		2 changeover contacts
Symbols with base conncections  Contacts in release condition, coil polarity to set the relay					
Contact assembly	single contacts	single contacts	single contacts	bifurcated contacts	single contacts
Contact material silver, gold-flashed Ordering code block 3	B112	C112	B110	C110	F 104
Contact material gold F Ordering code block 3	B612	C412	B610	C 410	

Size III

Number of contacts and type	6 changeover contacts		4 changeover contacts
Symbols with base conncections  Contacts in release condition, coil polarity to set the relay			
Contact assembly	single contacts	bifurcated contacts	single contacts
Contact material silver, gold-flashed Ordering code block 3	B133	C133	F110
Contact material gold F Ordering code block 3	B633	C433	

Coil Data

Nominal voltage	from 6 Vdc to 220 Vdc
Typical nominal power consumption, at 20°C	1 W
Class of the operative range acc to EN 61810-1 / IEC 61810-1 and VDE 0435 Part 201	2
Operating voltage (according to the coil type)	max. 92% of the nominal voltage

Coil version

Nominal voltage U_{nom} Vdc	Operating voltage range at 20° C: Minimum voltage U_I Vdc				Maximum voltage U_{II} Vdc	Resistance at 20° C Ω	Coil number Ordering code block 2
	Conctact sets: -B104/-B604/ -B110/-B610/ -B612/-F105/	-B133/-B633/-C104/ -C404/-C112/-C412/ -F104	C112 C104 F110	C133 C433			
6	2.4	2.9	3.5	4.5	9	33 ± 3.3	011
12	4.7	5.8	7.0	8.8	18	130 ± 13	015
24	10.5	13	15.5	20	39	630 ± 63	020
60	29	36	43	55	94	3800 ± 570	026
110	44	53.5	66	85	145	9200 ± 1380	004
125	59	73	88	112	190	15500 ± 2320	013
220	79	98	118	151	240	25000 ± 3750	003

Terminals:
Coil with 1 winding
Start 4 End 1

Coil with 2 windings (upon request)
Start 3 End 2 for winding I
Start 4 End 1 for winding II

The minimum voltage U_I depends on the contact set and the ambient temperature, the maximum voltage U_{II} only depends on the ambient temperature.

Between minimum voltage $U_{I\,tamb}$ and operating voltage U a safety margin of approx. 20% is recommended.

$U_{I\,tamb}\,(1.2) < U \leq U_{II\,tamb}$

$U_{I\,tamb} = U_{I\ 20°C} \cdot k_{I\,tamb}$

$U_{II\,tamb} = U_{II\ 20°C} \cdot k_{II\,tamb}$

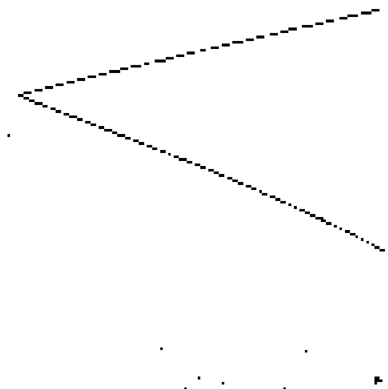
t_{amb} = Ambient temperature

U = Operating voltage

$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}

$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}

k_I and k_{II} = Factors



Note: Instructions for impulse operation see data sheet cradle relay N

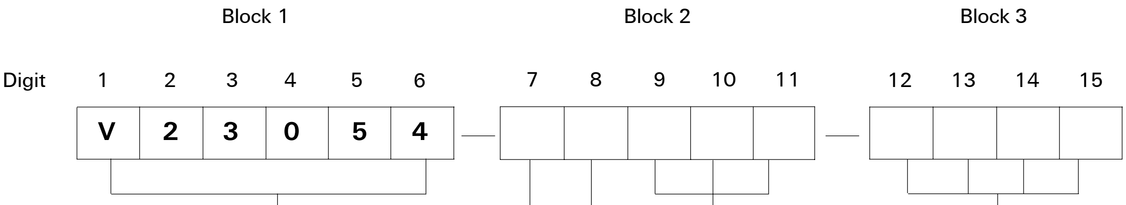
General data

Ordering code block 3	B1xx	B6xx	C1xx	C4xx	F1xx
Operating time at U_{nom} and 20° C, typical	16 ms				
Release time, typical	2 ms				
Maximum switching rate without load	50 operations/s				10 operations/s
Ambient temperature range acc. to EN 61810-1 / IEC 61810-1 and VDE 0435 part 201	-40° C ... +70° C				
Thermal resistance	40 K/W				
Maximum temperature	100° C				
Continious thermal load	2.1 W				
Degree of protection acc. to EN 60529 / IEC 60529 / VDE 0470 part 1	dust-protected IP 30				
Mechanical endurance	approx. 10^8 operations				approx. 10^7 operations
Mounting position	any				
Weight					
Size I	approx. 20 g				
Size II	approx. 25 g				
Size III	approx. 27 g				

Insulation

Ordering code block 3	B1xx	B6xx	C1xx	C4xx	F1xx
Test voltage (1 min)					
winding / frame	500 Vac_{rms}				500 Vac_{rms}
contact / contact	500 Vac_{rms}				1000 Vac_{rms}
contact / frame	500 Vac_{rms}				1000 Vac_{rms}

Ordering Code



Basic type number of cradle relay S

Relay type
C = Size I
D = Size II
E = Size III

0 = standard version
1 = fitted with contact sets F (block 3)
2 = for higher test voltage
3 = contact sets F and higher test voltage winding / frame

Coil number
Versions see page 5

Contact set / type of contact
see page 4

Ordering example:
V23054-E0020-C133
Cradle relay S, size III, standard version, coil 24 Vdc, 6 changeover contact set, bifurcated contacts, contact material silver, gold-flashed

Note:
The ordering scheme enables a multitude of variations. However, not all variations are defined as construction specifications (ordering code) and thus in the current delivery program.

Special design can be carried out to customer specifications. Please contact your local representative.

Ordering Information

Relay Code	Tyco Part Number
V23054D 20B110	5-1393812-1
V23054D 20C110	5-1393812-3
V23054D1020F104	9-1393812-3
V23054E 20B133	3-1393813-6
V23054E 22B133	4-1393813-4
V23054E1019F110	7-1393813-2
V23054E1020F110	7-1393813-6

Hand solder and plug-in relays,
for DC operation,
polarized, non-latching

Features

- Primarily intended for impulse operation
- highly reliable
- Multi purpose relay
- great variety of contact arrangements and materials to meet specific applications
- Sockets for easy and quick mounting of relays (see data sheet Accessories)
- Contacts for signal loads and currents up to 5 A

Typical applications

- For applications where the switching status must be maintained
- Measuring systems

Versions

- Size I or II, depending on contact set
- Standard contact sets with max. 4 changeover, 2 break or 6 make contacts, special configurations on request
- Single or bifurcated contacts
- Hand solder terminals also for plug-in connection with screw fixing
- Dust-protected

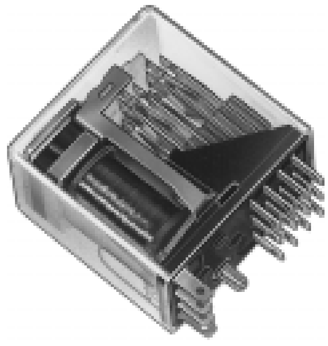
Version V23003-A0xxx Size I and
V23003-B0xxx Size II

Hand solder terminals, silver-plated

Also for plug-in connection
and screw fixing

With earth terminal

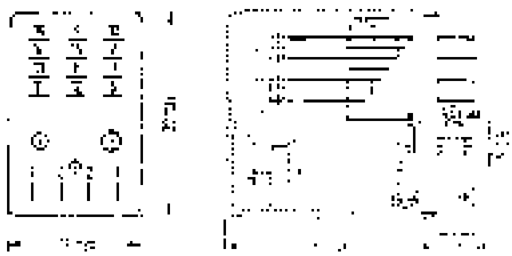
Dust-protected



Dimension drawing (in mm)

Size I

Size II

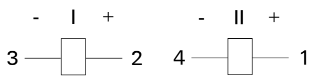
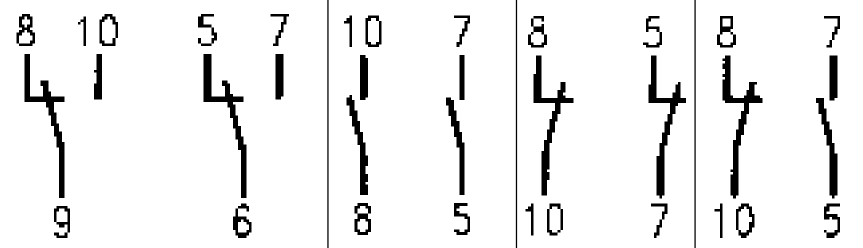


Contact Data

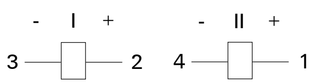
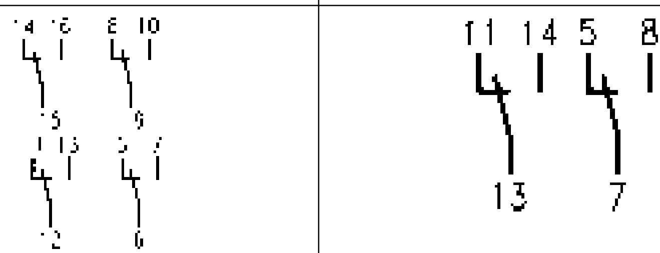
Ordering code block 3	B104/B110/	B604/B610/	C104/C110	C404/C410	F104 ... F107
Type of contact	max. 4 changeover contacts, 2 break contacts or 6 make contacts				
Contact assembly	single contacts		bifurcated contacts		single contacts
Contact material	silver, gold-flashed	gold F	silver, gold-flashed	gold F	silver, gold-flashed
Max. switching voltage	150 Vdc 125 Vac	36 Vdc 30 Vac	150 Vdc 125 Vac	36 Vdc 30 Vac	250 Vdc 250 Vac
Max. switching current	2 A	0.2 A	2 A	0.2 A	5 A
Max. switching capacity	35 to 70 W see load limit curve page 7 50 VA	5 W 5 VA	35 to 70 W see load limit curve page 7 50 VA	5 W 5 VA	50 to 140 W see load limit curve page 7 500 VA
Max. continuous current at max. ambient temperature	2 A				5 A

Contact sets

Size I

Number of contacts and type	2 changeover contacts		2 make contacts	2 break contacts	1 break 1 make contact
Symbols with base conncections  Contacts in release condition, coil polarity to set the relay					
Contact assembly	single contacts	bifurcated contacts	single contacts		
Contact material silver, gold-flashed Ordering code block 3	B104	C104	F105	F107	F106
Contact material gold F Ordering code block 3	B604	C404			

Size II

Number of contacts and type	4 changeover contacts		2 changeover contatcs
Symbols with base conncections  Contacts in release condition, coil polarity to set the relay			
Contact assembly	single contacts	bifurcated contacts	single contacts
Contact material silver, gold-flashed Ordering code block 3	B110	C110	F 104
Contact material gold F Ordering code block 3	B610	C410	

Coil Data

Nominal voltage	from 6 Vdc to 60 Vdc
Typical nominal power consumption, at 20°C	1.5 W
Class of the operative range acc to EN 61810-1 / IEC 61810-1 and VDE 0435 Part 201	1
Operating voltage (according to the coil type)	max. 73% of the nominal voltage

Coil version

Nominal voltage U_{nom}	Operating voltage range at 20° C		Win-ding	Terminals		Resistance at 20° C	Coil number Ordering code block 2
	Minimum voltage U_I	Maximum voltage U_{II}					
Vdc	Vdc	Vdc		Start	End	Ω	
6	4.0	6.7	I	3	2	24.5 ± 2.5	026
	4.0	6.7	II	4	1	24.5 ± 2.5	
12	8.0	13.5	I	3	2	100 ± 10	025
	8.0	13.5	II	4	1	100 ± 10	
24	16.5	26.5	I	3	2	400 ± 60	037
	16.5	25	II	4	1	340 ± 34	
48	33.5	49	I	3	2	1400 ± 210	064
	33.5	49	II	4	1	1400 ± 210	
60	44	65	I	3	2	2400 ± 360	044
	44	65	II	4	1	2400 ± 360	

With continuous operation only one winding at a time may be energized within the specific voltage range.

The minimum voltage U_I and the maximum voltage U_{II} depends on the ambient temperature.

$U_{I\,tamb} = U_{I\;20°C} \cdot k_{I\,tamb}$

$U_{II\,tamb} = U_{II\;20°C} \cdot k_{II\,tamb}$

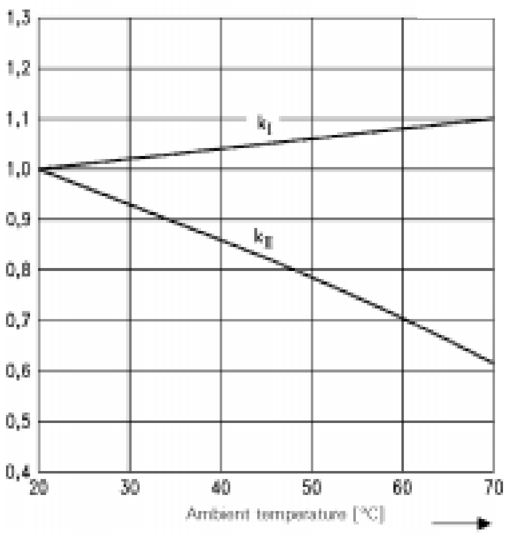
t_{amb} = Ambient temperature

$U_{I\,tamb}$ = Minimum voltage at ambient temperature, t_{amb}

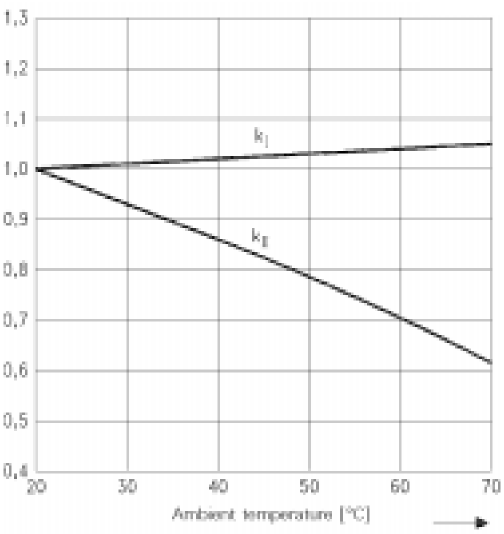
$U_{II\,tamb}$ = Maximum voltage at ambient temperature, t_{amb}

k_I and k_{II} = Factors

Operate - negative potential at start of winding



Operate - negative potential at start of winding



Instructions for impulse operation

Cradle relay P is primarily intended for impulse operation. The maximum voltage stated in the table (page 5) can be increased for impulse operation as follows:

$U_{II\,Impuls}$ = $U_{II\,tamb} \cdot q$
$U_{II\,tamb}$ = Maximum continuous voltage at ambient temperature t_{amb}
q = Factor

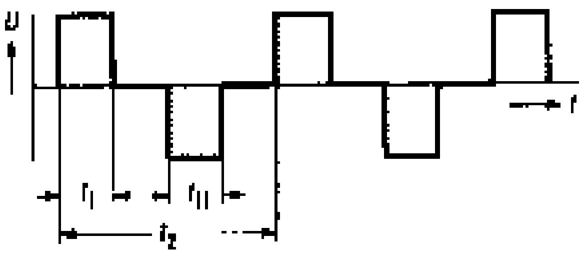
The impulse voltage must not exceed 80% of the test voltage (winding/frame or winding/winding) or 3.3 times at ambient tem-perature =20 °C and 2.3 times at ambient temperature < 20 °C the value of the maximum voltage listed in the table (page 5).

If $t_{ED} \leq 3$ s then $q = \sqrt{\frac{t_z}{t_{ED}}}$

If t_{ED} = Pulse width
t_2 = Cycle time
If t_{ED} = > 3 s the value of q must be obtained from the nomograph (cradle relay N datasheet page 10).

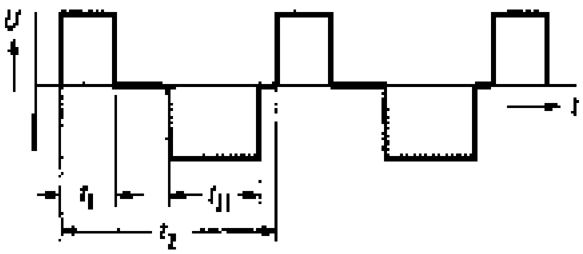
Examples of various periodic pulse trains (energizing side)

1. Periodic recurrence of one energizing pulse



t_{ED} = $t_I + t_{II}$
t_I = Pulse width of the positive pulse at the start of the winding
t_{II} = Pulse width of the negative pulse at the start of the winding
$t_I + t_{II}$ = Pulse widths within one cycle

2. Periodic recurrence of two unequal energizing pulses



General data

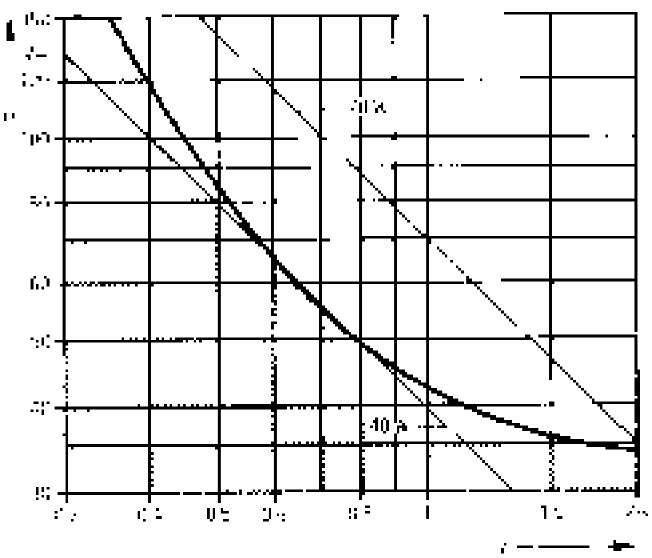
Operating time at U_{nom} and 20° C, typical	4 ms
Release time, typical	4 ms
Maximum switching rate without load	20 operations/s
Ambient temperature range acc. to EN 61810-1 / IEC 61810-1 and VDE 0435 part 201	-40° C ... +70° C
Thermal resistance	50 K/W
Maximum temperature	100° C
Continious thermal load	1.6 W
Degree of protection acc. to EN 60529 / IEC 60529 / VDE 0470 part 1	dust-protected IP 30
Mechanical endurance	approx. 10^7 operations
Mounting position	any
Weight	
Size I	approx. 25 g
Size II	approx. 30 g

Ordering code block 3	B1xx	B6xx	C1xx	C4xx	F1xx
Test voltage (1 min)					
winding / frame	500 Vac_{rms}				500 Vac_{rms}
contact / contact	500 Vac_{rms}				1000 Vac_{rms}
contact / frame	500 Vac_{rms}				1000 Vac_{rms}

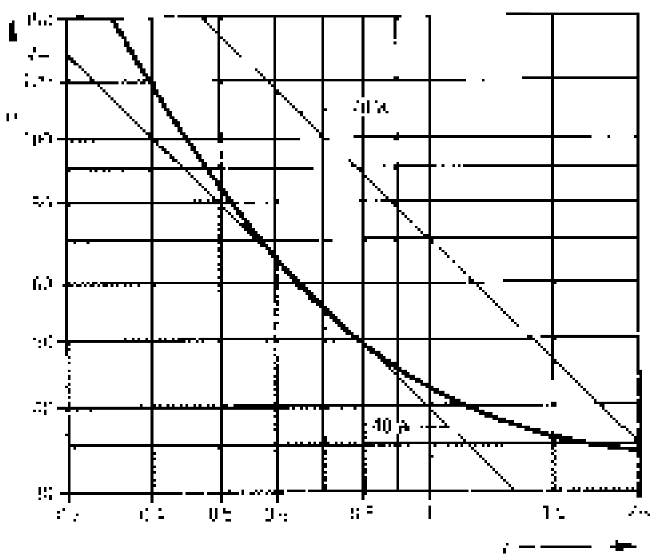
Load limit curve

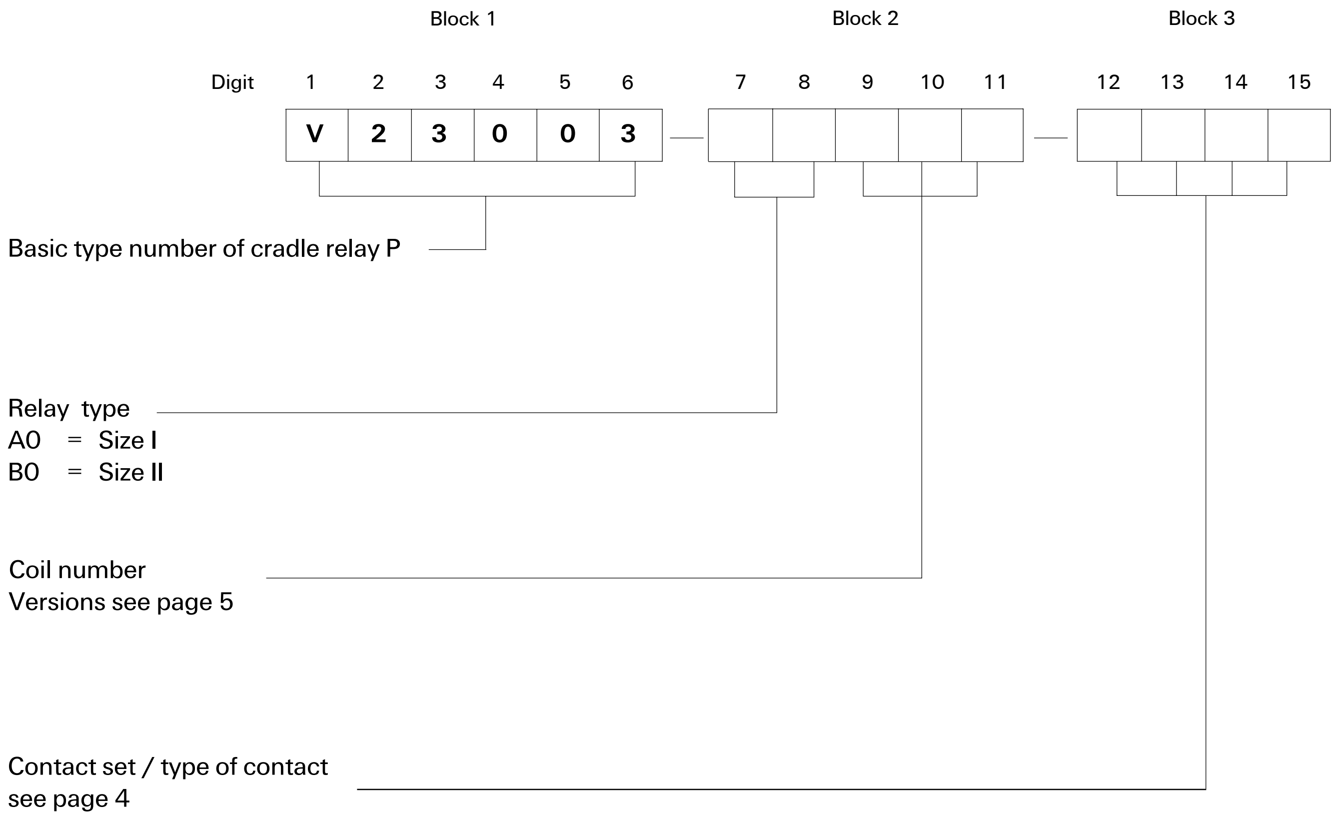
Safe breaking, no stationary arc
Contact material silver, gold-flashed

Contact sets B1xx and C1 xx



Contact sets F1xx





Ordering example:
V23003-B0037-F104
Cradle relay P, size II, dust-protected, coil 24 Vdc, 2 changeover contact set, single contacts, contact material silver, gold-flashed

Note:
The ordering scheme enables a multitude of variations. However, not all variations are defined as construction specifications (ordering code) and thus in the current delivery program.

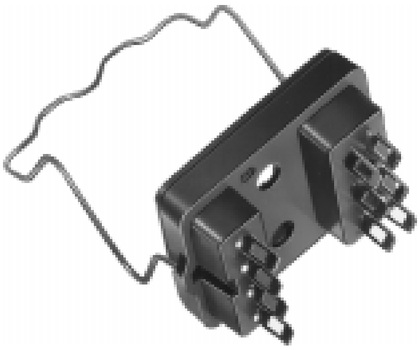
Special design can be carried out to customer specifications. Please contact your local representative.

Ordering Information

Relay Code	Tyco Part Number
V23003A 44B104	1-1393817-8
V23003B 37B110	3-1393817-9
V23003B 37C110	4-1393817-1
V23003B 37F104	4-1393817-5
V23003B 64B110	6-1393817-3

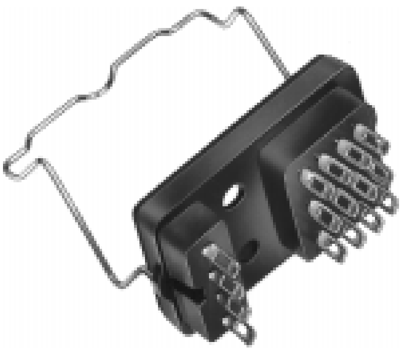
Sockets with hand solder terminals

Size I



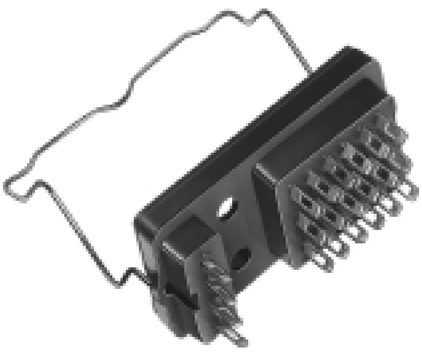
Approx. weight 3.5 g

Size II



Approx. weight 4.5 g

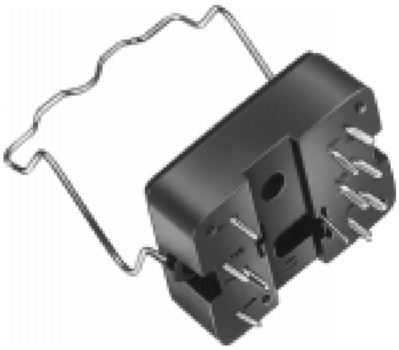
Size III



Approx. weight 5.5 g

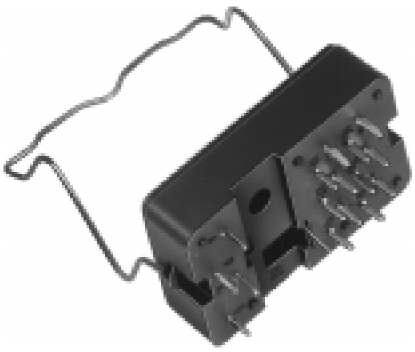
Sockets with PCB terminals

Size I



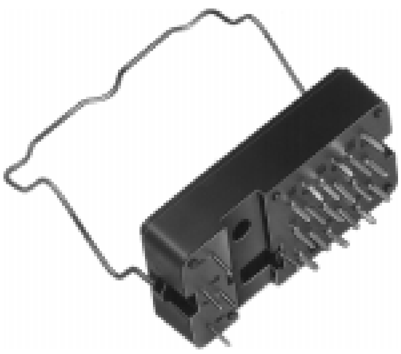
Approx. weight 4.5 g

Size II



Approx. weight 5.5 g

Size III



Approx. weight 6.5 g

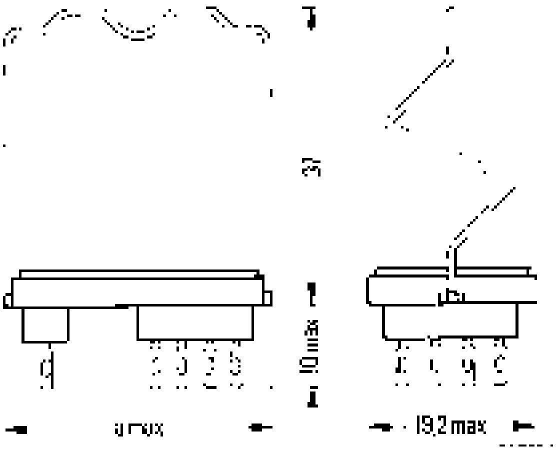
AXICOM

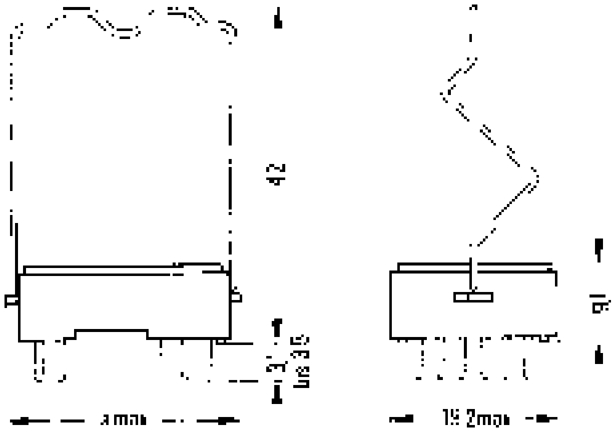
Sockets with hand solder terminals

Sockets with PCB terminals

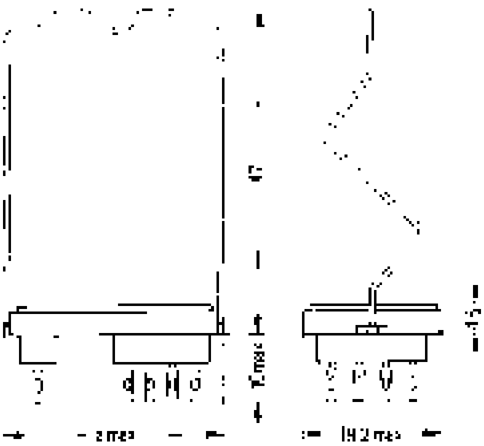
Dimension drawing (in mm)

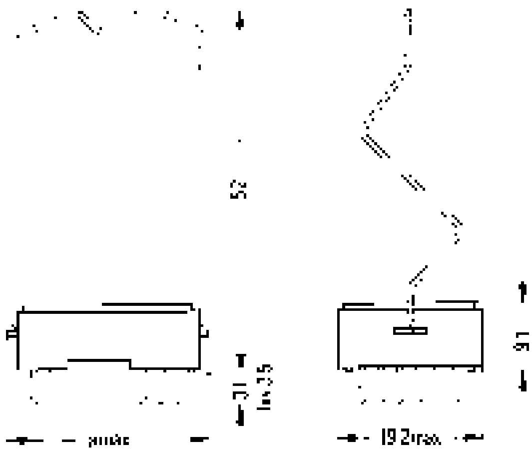
with hold-down spring for cradle relays N, S and P





with hold-down spring for cradle relay W





Socket	Size I	Size II	Size III
Dimension a	26.6	32.5	38

Ordering Code

Version	Size	Ordering code	Tyco Part Number
Sockets			
for printed circuit mounting,	I	V23154-Z1001	0-1393824-1
terminals silver-plated	II	V23154-Z1002	9-1393809-1
with earth terminal	III	V23154-Z1028	1-1393824-0
for solder terminals,	I	V23154-Z1005	0-1393824-4
hand solder terminals, silver-plated	II	V23154-Z1006	0-1393824-5
	II	V23154-Z1015	0-1393824-8
Hold-down springs			
for cradle relays N, S and P	I	V23154-Z1021	0-1393824-5
	II	V23154-Z1022	0-1393827-2
	III	V23154-Z1034	0-1393760-2
for cradle relay W	I	V23154-Z1023	0-1393827-3
	II	V23154-Z1024	0-1393760-1

Gold plated terminals on request

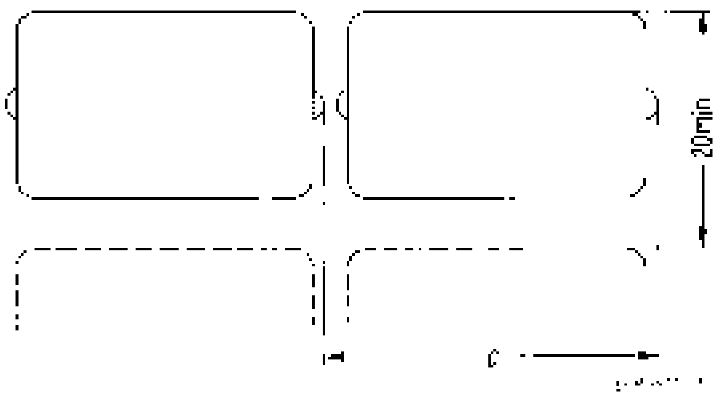
General Data

Terminal material	CuSn8 FB 390 plated with min. 3 μm silver or min. 1 μm gold
Socket material with solder terminals	Phenolformaldehyde - type 31 (DIN 7708, part 2)
Socket material with PCB terminals	Makrolon (polycarbonate)
Maximum continous current at 70° C	5 A

Minimum spacings between sockets

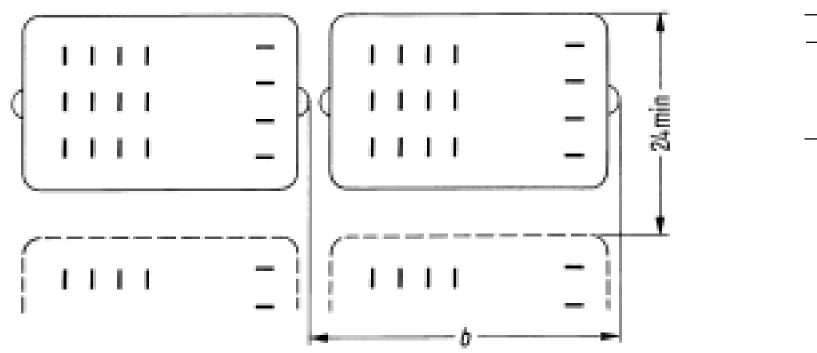
Dimension drawing (in mm)

with hold-down spring for cradle relays N, S and P



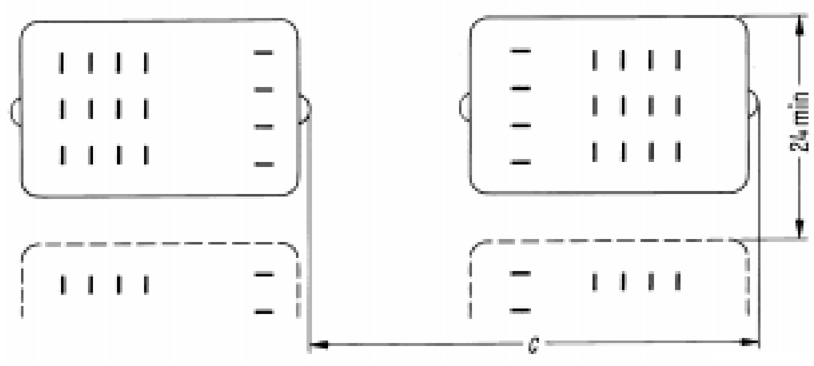
Socket	Dimension c
Size I	27
Size II	33
Size III	39

for cradle relay P
Relays oriented in the same direction



Socket	Dimension b	Dimension c
Size I	27	42
Size II	33	48
Size III	39	54

Relays oriented inversely to each other



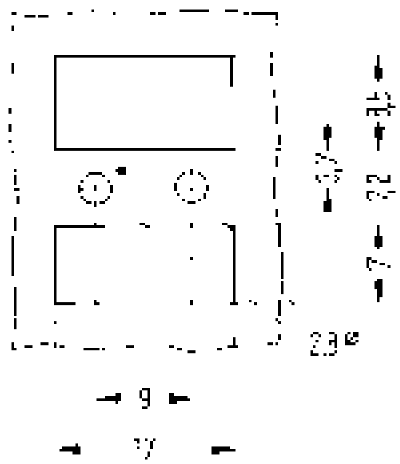
When mounting cradle relay P consideration should be given to magnetic fields. Strong DC magnetic fields, possibly caused by adjacent relays, and large iron masses are the most common causes of interference. Experience has shown that under normal operating conditions the minimum spacings specified for cradle relay P are sufficient to prevent cross interference.

Mounting hole layout for cradle relays and sockets with hand solder terminals

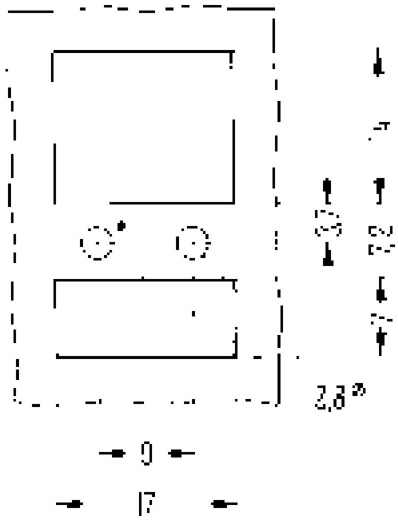
Dimension drawing (in mm)

with hold-down spring for cradle relays N, S and P

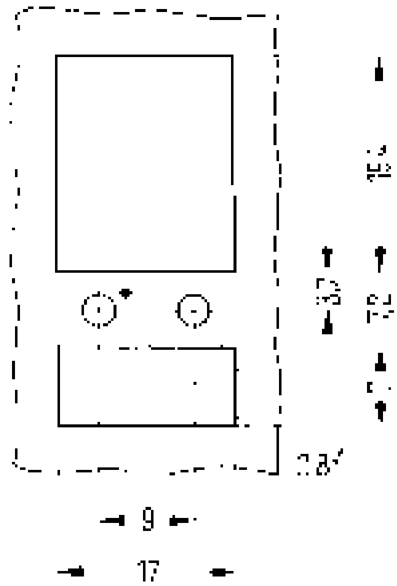
Size I



Size II

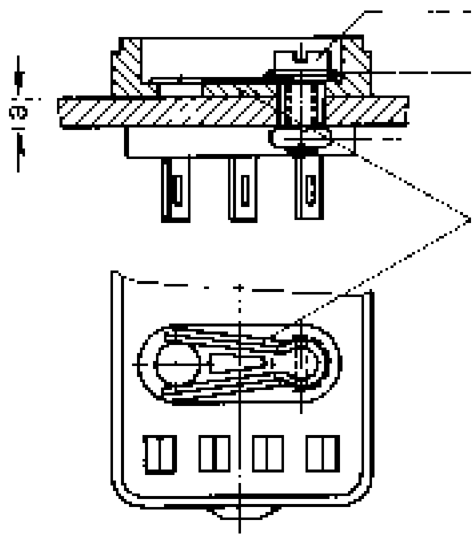


Size III



*) This hole is omitted when the mounting hole layout is intended for the socket.

Fixing of the socket

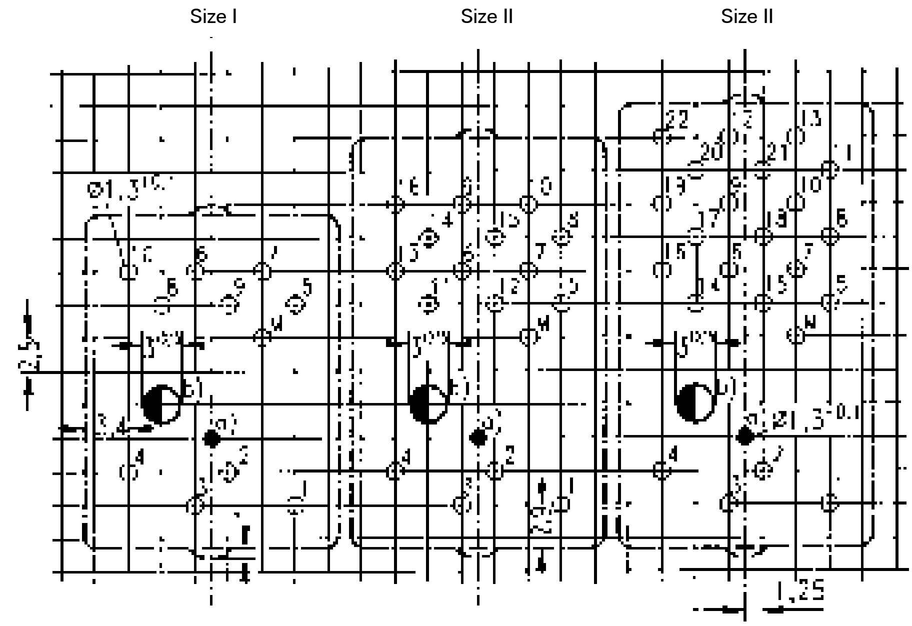


Direct mounting of relays without socket requires a fixing nut M2.5 DIN 934-m6AU.
Ordering code: D00934-A0025-S001

Mounting hole layot for sockets with PCB terminals

Basic grid 2.5 mm according to EN 60097

Dimension drawing (in mm)

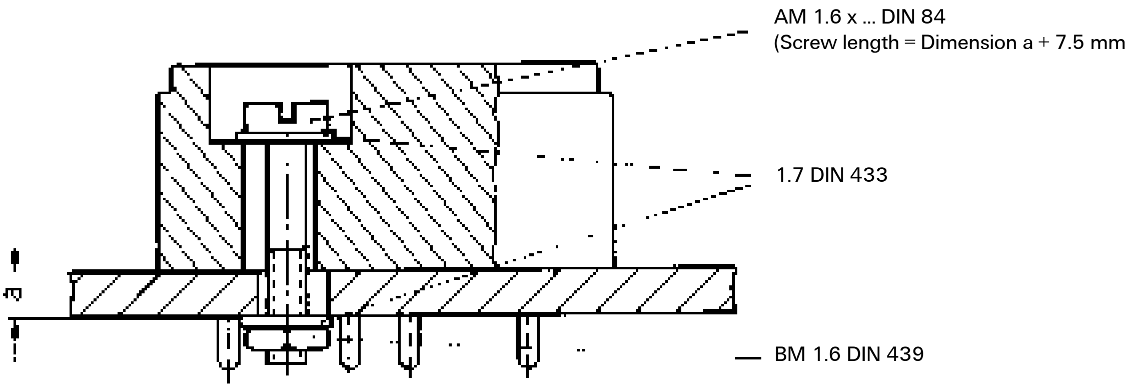


View onto the terminals

M = Earth terminal

a) Hole for mechanical armature actuation, if required
b) Hole for the socket mounting with screw M1.6

Fixing of the socket



Tyco Electronics AXICOM Ltd.
Seestrasse 295 - P.O. Box 220
CH-8804 Au-Wädenswil / Switzerland
Phone +41 1 782 9111
Fax +41 1 782 9080
E-mail: axicom@tycoelectronics.com

Tyco Electronics AMP GmbH
Paulsternstrasse 26
D-13629 Berlin / Germany
Phone +49 30 386 38260
Fax +49 30 386 38569
E-mail: axicom@tycoelectronics.com

Tyco Electronics EC Trutnov s.r.o.
Komenského 821
CZ-541 01 Trutnov / Czech Republic
E-mail: axicom@tycoelectronics.com

Tyco Electronics Corporation
POB 3608,
Harrisburg, PA 17105, USA
Phone +1 800-522-6752

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