Application Note #2

Transportation, Storage, Handling, Assembly and Testing of AXICOM SMT Relays

Electromechanical relays are one of the most robust and most reliable electronic components. In order to achieve and guarantee the excellent performance of AXICOM relays, some precautions must be taken during transportation, storage, handling and assembly and testing of the relays.

Following this guideline enables proper treatment of the relays during the critical phase in the relay life.

A. Transportation

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. Whenever relays arrive in **damaged boxes** at customer sides, there is a potential risk of transportation damage.
Damaged boxes shall be detected during incoming inspection. From damaged boxes a photo shall be taken and immediately a claim to the forwarder should be made**.**
Depending on the degree of damage further actions are required. Relays from heavily damaged boxes should not be used. Relays in minor damaged boxes should be still acceptable, as the build in shock absorbers should have protected the relays. A feasible way is to mark the reel, when removing the box and make a controlled run on the SMT line.

Fig. 1: Proper packing of relays for transportation

B. Packaging

Different packaging is used depending on the relay type and with regard to any specific requirements during shipment or production. The standard packing for SMT relays are blisters wounded on a reel (tape & reel) and dry packed in order to prevent the relays from catching humidity.

Fig. 2: Dry packed SMT relays

AXICOM SMT relays should be kept in the "Pizza Boxes" for storage and should be removed from the box just before the assembly process directly on the SMT assembly line. Pizza boxes are equipped with shock absorbers, which protect the relays from mechanical impacts

Fig. 3: "Pizza Box" for protection of the relays. Opened box with shock absorbers on the right hand side

C. 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. Especially care must be taken, that relays are **not dropped to the floor**. Dropped relays shall not be used anymore and shall be scraped.

Special care should be taken during splicing the reels, so loose end of tape shall not drop to the floor during splicing the tape. During splicing special care must be taken, that the terminals of the relays are not bent.

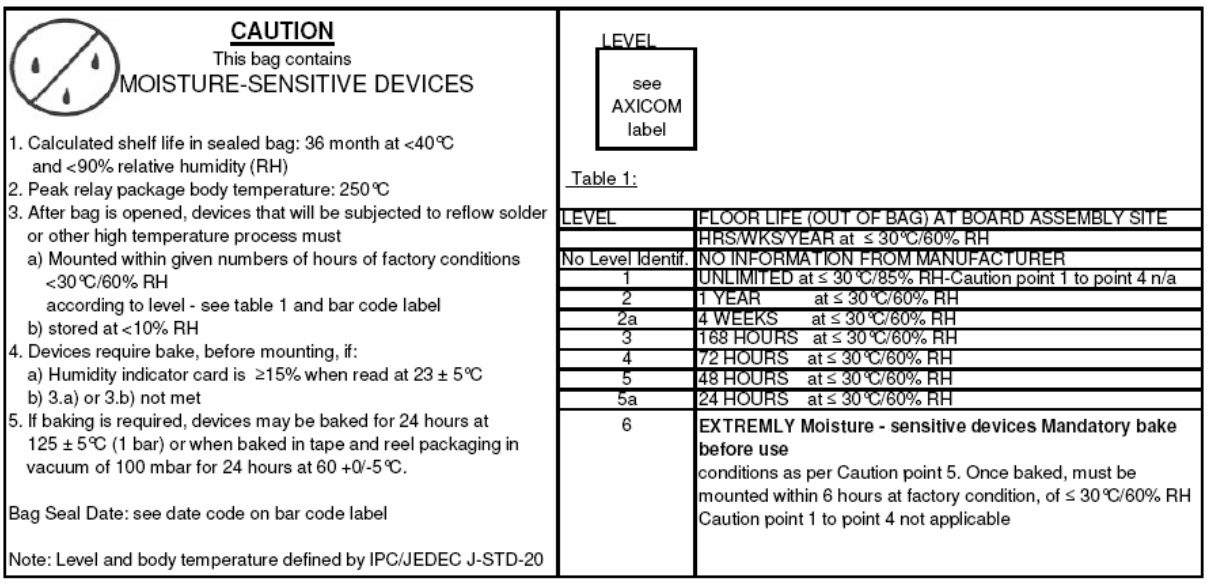
D. Storage

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 dry when soldered and the higher the peak temperature the more important become this. For this reason all AXICOM SMD relays are dry packed. When the packing is opened, the relays must be soldered in a defined time, which is given by the moisture sensitive level MSL. MSL3 means that the parts must be soldered latest 168 hours after opening of the bag. Remaining relays shall be dry repacked again

LEVEL	FLOOR LIFE		SOAK REQUIREMENTS			
			STANDARD		ACCELERATED EQUIVALENT [1]	
	TIME	CONDITIONS	TIME (hours)	CONDITIONS	TIME (hours)	CONDITIONS
1	Unlimited	≤30°C/85% RH	168 +5/-0	85°C/85% RH		
2	1 year	≤30°C/60% RH	168 +5/-0	85°C/60% RH		
2a	4 weeks	≤30°C/60% RH	696[2] +5/-0	30°C/60% RH	120 +1/-0	60°C/60% RH
3	168 hours	≤30°C/60% RH	192[2] +5/-0	30°C/60% RH	40 +1/-0	60°C/60% RH
4	72 hours	≤30°C/60% RH	96[2] +2/-0	30°C/60% RH	20 +0.5/-0	60°C/60% RH
5	48 hours	≤30°C/60% RH	72[2] +2/-0	30°C/60% RH	15 +0.5/-0	60°C/60% RH
5a	24 hours	≤30°C/60% RH	48[2] +2/-0	30°C/60% RH	10 +0.5/-0	60°C/60% RH
6	Time on Label (TOL)	≤30°C/60% RH	TOL	30°C/60% RH		

Table 1: Moisture sensitive level according JEDEC J-STD-33

When the open time is exceeded, relays must be dried before soldering. Drying instructions are given in Table 2.



CAUTION
This bag contains
MOISTURE-SENSITIVE DEVICES

1. Calculated shelf life in sealed bag: 36 month at <40°C and <90% relative humidity (RH)
2. Peak relay package body temperature: 250°C
3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must
   a) Mounted within given numbers of hours of factory conditions <30°C/60% RH according to level - see table 1 and bar code label
   b) stored at <10% RH
4. Devices require bake, before mounting, if:
   a) Humidity indicator card is ≥15% when read at 23 ± 5°C
   b) 3.a) or 3.b) not met
5. If baking is required, devices may be baked for 24 hours at 125 ± 5°C (1 bar) or when baked in tape and reel packaging in vacuum of 100 mbar for 24 hours at 60 +0/-5°C.

Bag Seal Date: see date code on bar code label

Note: Level and body temperature defined by IPC/JEDEC J-STD-20

LEVEL
see AXICOM label

Table 1:

LEVEL	FLOOR LIFE (OUT OF BAG) AT BOARD ASSEMBLY SITE
	HRS/WKS/YEAR at ≤ 30°C/60% RH
No Level Identif.	NO INFORMATION FROM MANUFACTURER
1	UNLIMITED at ≤ 30°C/85% RH-Caution point 1 to point 4 n/a
2	1 YEAR at ≤ 30°C/60% RH
2a	4 WEEKS at ≤ 30°C/60% RH
3	168 HOURS at ≤ 30°C/60% RH
4	72 HOURS at ≤ 30°C/60% RH
5	48 HOURS at ≤ 30°C/60% RH
5a	24 HOURS at ≤ 30°C/60% RH
6	**EXTREMLY Moisture - sensitive devices Mandatory bake before use** conditions as per Caution point 5. Once baked, must be mounted within 6 hours at factory condition, of ≤ 30°C/60% RH Caution point 1 to point 4 not applicable

Table 2: Drying instructions

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.

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.

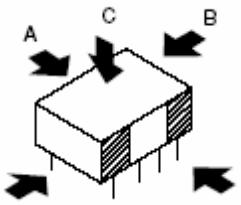


Fig. 4: Clamping of relays in x-y-z direction

Clamping force shall not exceed the values given for x, y, z direction, in order to guarantee the proper internal function of the relay. The force shall be applied in the largest possible area. Picking in the dashed area would be preferred

Clamping force: x – direction: ≤ 5 N
y – direction: ≤ 5 N
z – direction: ≤ 5 N

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.

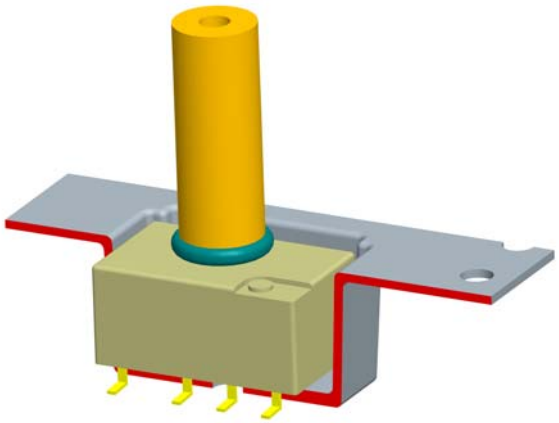
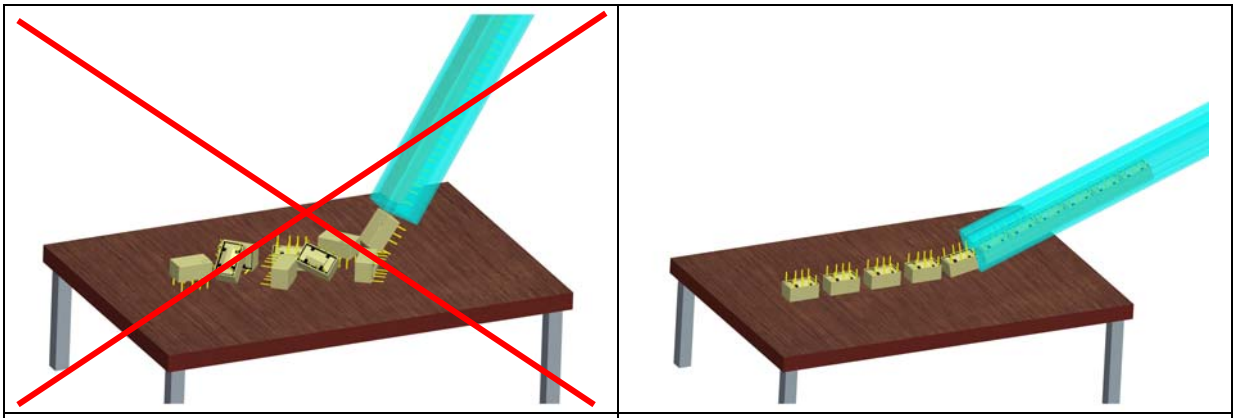


Fig. 5: Whenever possible a nozzle with a rubber ring should be used, in order to prevent unintentionally high mechanical shock

G. Manual handling

When relays are manually placed on PCB's, relays shall not dropped into a bin or on a hard table. They shall directly be picked from the tube, in order to prevent bent terminals and excess mechanical shock.
Relays which were dropped to the floor or from a height of more than 250 mm are potentially damaged. After long storage at high temperature it might happen that relays are picking on the plug and are suddenly released. This might cause a major mechanical shock and might destroy the relay.



Do not pour relays from tube not orientated to a hard table	Relays shall be placed carefully on a plate and the plate should be covered with some soft material

Fig. 6: Proper and improper release of relays from the tube.

H. 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.

I. 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.

J. 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.

K. 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.

L. SMT Soldering

The soldering should be carried out according to the recommendation of IEC 60068-2-58 if not stated otherwise in the respective datasheet.

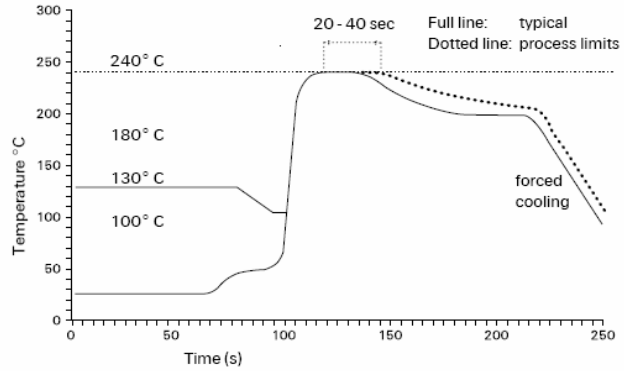


Fig. 7: SMT soldering profiles for vapour phase soldering (VPS)

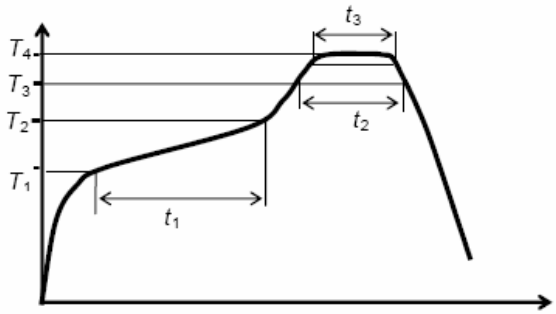


Figure 2a "hat" type

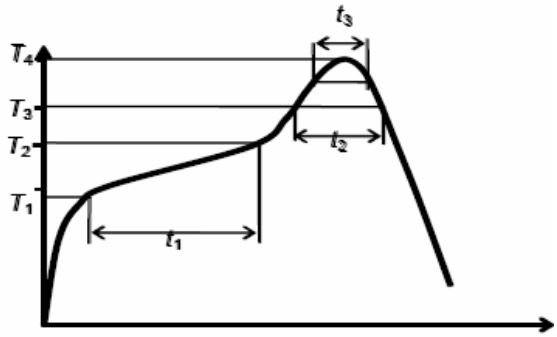


Figure 2b "Angle" type

Where ; T_1 :Minimum preheating temperature
T_2 :Maximum preheating temperature
T_3:Soldering temperature
T_4 :Peak temperature
t_1:Preheating duration
t_2:Soldering duration
t_3 :Peak temperature duration

Test	Reflow profile	T_1 °C	T_2 °C	t_1 s	T_3 °C	t_2 s	T_4 °C	t_3 s
1	Figure 2a	150 ± 5	180 ± 5	120 ± 5	220	60 - 90	250	20 - 40 @ T_4 - 5K
2	Figure 2b	150 ± 5	180 ± 5	120 ± 5	220	≤ 60	255	≤ 20 @ T_4 -10K

Fig. 8: SMT soldering profiles for reflow soldering (according IEC 60068-2-58) maximum temperatures and durations. Check minimum temperatures and durations for proper soldering results.

In general, electromechanical relays should be soldered at the lower process limits of a soldering process. However, the SMT soldering process has a lot more aspects than those covered by this standard. From the relay side, the oven type has an impact on the temperature stress. While infrared ovens are replacing the convection ovens because of their more homogeneous heat distribution, the impact on relays can be negative because the convection heats up the relays faster inside. Plastic molded parts inside the relay can relax or deform which mostly leads to a change in operate and release voltages.
The different reflow soldering processes such as IR, convection and combined ovens and vapor phase are described in Tab. 1.

Soldering technology	**Temperature stress**	**Effects**
Infrared (IR)	*High to very high* Radiation temperature >> soldering temperature	*Housing warmer than terminals* ΔT 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. 1: Impact of soldering equipment on relays

M. 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 265°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.

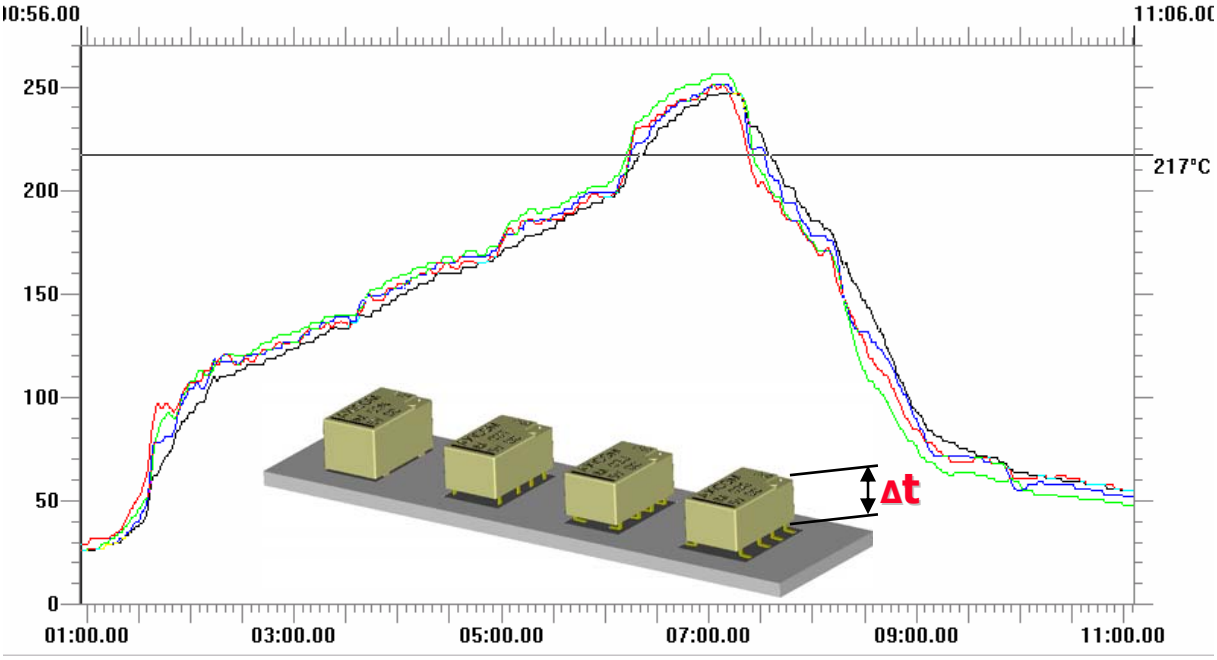


Fig. 9: For good results during the soldering process, the temperature must be adjusted accordingly. Most important is to keep the temperature difference between relay terminals and body as small as possible.

N. 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 – A tip temperature of 300°C and a soldering time of 3 s shall not be exceeded.

O. Chemical cleaning

In modern PCB assembly less and less cleaning is used as many no clean fluxes are already available on the market. If cleaning is necessary, certain precautions have to be taken.
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.
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.
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, alcohol 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.

Special care must be taken on the temperature of the cleaning and rinsing liquid. The temperature of the washing and rinsing liquid shall be similar and not deviate by more than 10 °C.

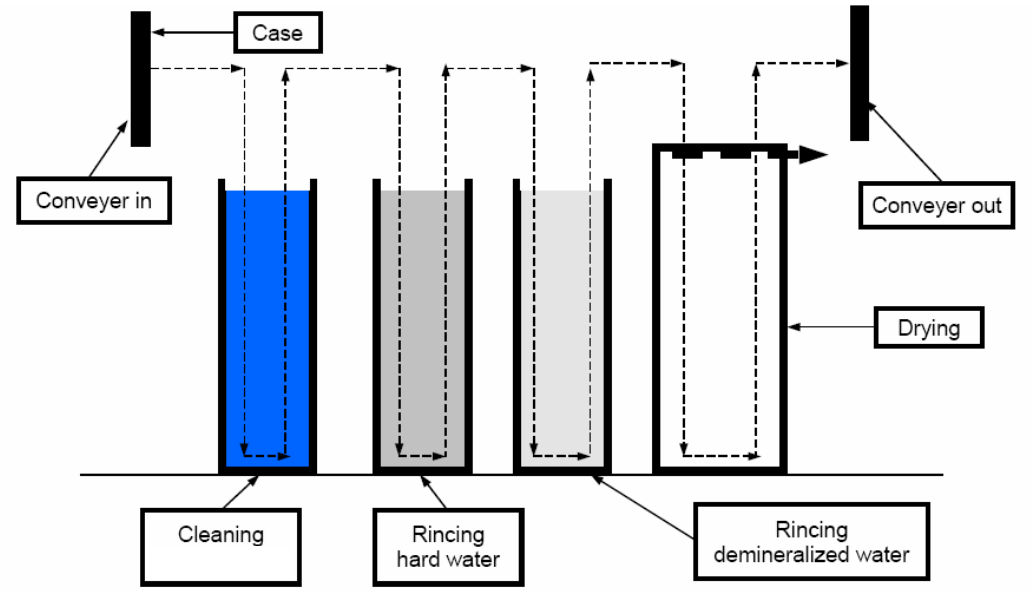


Fig. 10: Cleaning of PCB's. It is most essential to keep the temperature level during cleaning, rincing and drying constant. The temperature shall not deviate by more than ±10°C.

Ultrasonic cleaning is strongly not recommended for signal relays, as this might result in cold welding of the gold contacts.

P. Coating

Coating of relays on PCB's is basically possible. Only relays which are at least wash tight (RTIII) can be coated. In case relays with less protection are coated, there is a high risk that resin will enter the relay and destroy the relay.
Suitable are Epoxy, Urethane and Fluorine coatings. **Absolutely forbidden** are Silicone coatings.

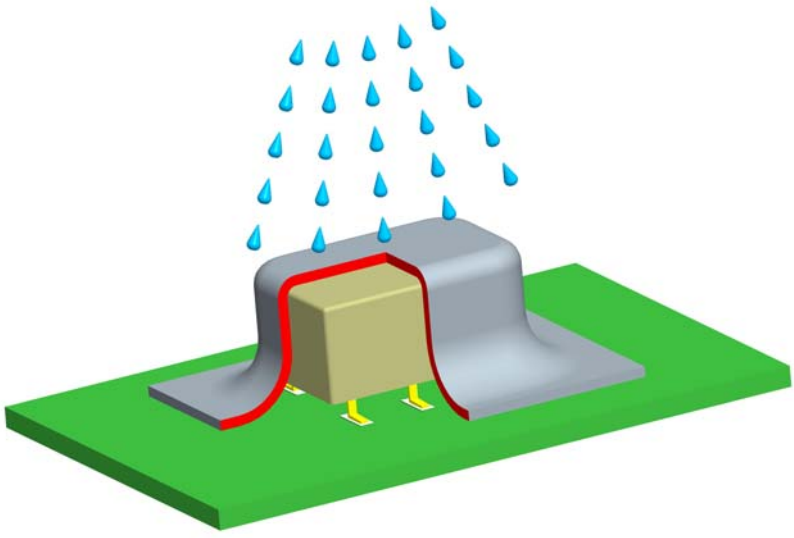


Fig. 11: Coating of relays on PCB's