

SOLDERING RECOMMENDATIONS

Popular soldering techniques used for surface mount components are Wave and Infrared Reflow processes. Both processes can be performed with Pb-containing or Pb-free solders. The termination options available for these soldering techniques are AgPd and Barrier Type End Terminations.

End termination	Designation	Recommended and Suitable for	Component RoHS Compliant
Ag/Pd	Series _(ZV,AV,DV,C,...)R1	Pb-containing soldering	Yes
Barrier Type End Termination	Series _(ZV,AV,DV,C,...)N R1	Pb-containing and Pb-free soldering	Yes

Wave Soldering - this process is generally associated with discrete components mounted on the underside of printed circuit boards, or for large top-side components with bottom-side mounting tabs to be attached, such as the frames of transformers, relays, connectors, etc. SMD varistors to be wave soldered are first glued to the circuit board, usually by an epoxy adhesive. When the PCB has been fully populated and an appropriate time is allowed for adhesive curing, the completed assembly is then placed on a conveyor and run through a single or double wave process.

Infrared Reflow Soldering - these reflow processes are typically associated with top-side component placement. This technique utilizes a mixture of adhesive and solder compounds (and sometimes fluxes) that are blended into a paste. The paste is then screened onto PCB soldering pads specifically designed to accept a particular sized SMD component. Recommended solder paste wet layer thickness is 100 to 300 μm. Once the circuit board is fully populated with SMD components, it is placed in a reflow environment, where the paste is heated to slightly above its eutectic temperature. When the solder paste reflows, the SMD components are attached to the solder pads.

Solder Fluxes - solder fluxes are generally applied to populated circuit boards to clean oxides from forming during the heating process and to facilitate the flowing of the solder. Solder fluxes can be either a part of the solder paste compound or can be separate materials, usually fluids. Recommended fluxes are:

- Non-activated (R) fluxes, whenever possible
- Mildly activated (RMA) fluxes of class L3CN
- Class ORLO

Activated (RA), water soluble or strong acidic fluxes with chlorine content > 0.2 wt.% are **NOT RECOMMENDED**. Use of such fluxes could create high leakage current paths along the body of the varistor components.

When a flux is applied prior to wave soldering, it is important to completely dry any residual flux solvents prior to the soldering process.

Solders - recommended solders are Pb-free (Sn96 / Cu0,4-0,8/ Ag3-4) or Pb-containing (62Sn / 36Pb / 2Ag) ones.

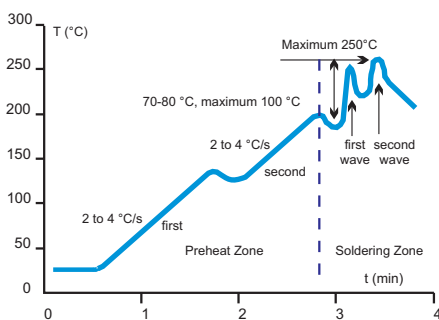


Fig. 1. Wave Soldering Temperature Profile for Pb-free and Pb-containing Soldering

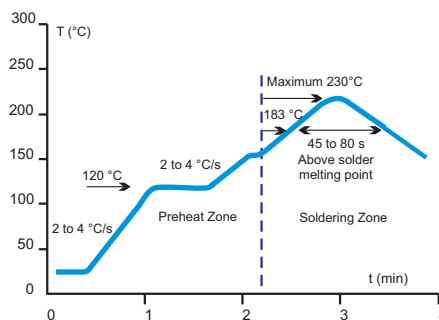


Fig. 2. Infrared Reflow Temperature Profile for Pb-containing Soldering

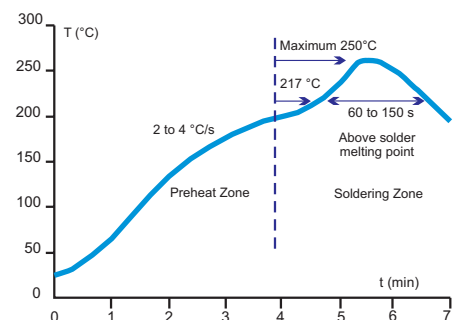


Fig. 3. Reflow Temperature Profile for Pb-free Soldering

Thermal Shock - to avoid the possibility of generating stresses in the varistor chip due to thermal shock, a preheat stage to within 100 °C of the peak soldering process temperature is recommended. Additionally, SMD varistors should not be subjected to a temperature gradient greater than 4 °C/sec, with an ideal gradient being 2 °C/sec. Peak temperatures should be controlled. Wave and Reflow soldering conditions for SMD varistors with Pb-containing solders are shown in Fig. 1 and 2 respectively, while Wave and Reflow soldering conditions for SMD varistors with Pb-free solders are shown in Fig. 1 and 3.

Whenever several different types of SMD components are being soldered, each having a specific soldering profile, the soldering profile with the least heat and the minimum amount of heating time is recommended. Once soldering has been completed, it is necessary to minimize the possibility of thermal shock by allowing a hot PCB to cool to less than 50 °C before cleaning.

Inspection Criteria - the inspection criteria to determine acceptable solder joints, when Wave or Infrared Reflow processes are used, will depend on several key variables, principally termination materials and process profiles.

Pb-containing Wave and IR Reflow Soldering - typical “before” and “after” soldering results for Silver/Palladium (AgPd) and Barrier Type End Terminations are given in Fig. 4. Both barrier type and silver/palladium terminated varistors form a reliable electrical contact and metallurgical bond between the end terminations and the solder pads. The bond between these two metallic surfaces is exceptionally strong and has been tested by both vertical pull and lateral (horizontal) push tests. The results, in both cases, exceed established industry standards for adhesion.

The solder joint **appearance** of a barrier type terminated versus a silver/palladium terminated varistor will be slightly different. Solder forms a metallurgical junction with the thin tin-alloy (over the barrier layer), and due to its small volume “climbs” the outer surface of the termination, forming a classical meniscus. Due the surface tension characteristics of silver/palladium terminations, the meniscus will be slightly lower. This optical appearance difference should be taken into consideration when programming visual inspection of the PCB after soldering.

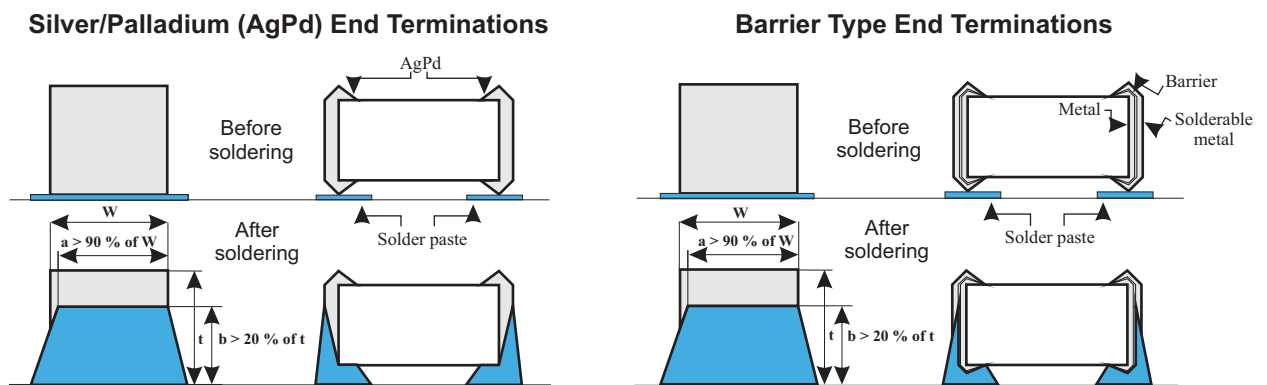


Fig. 4. Soldering Criterion in case of Wave and IR Reflow Pb-containing Soldering

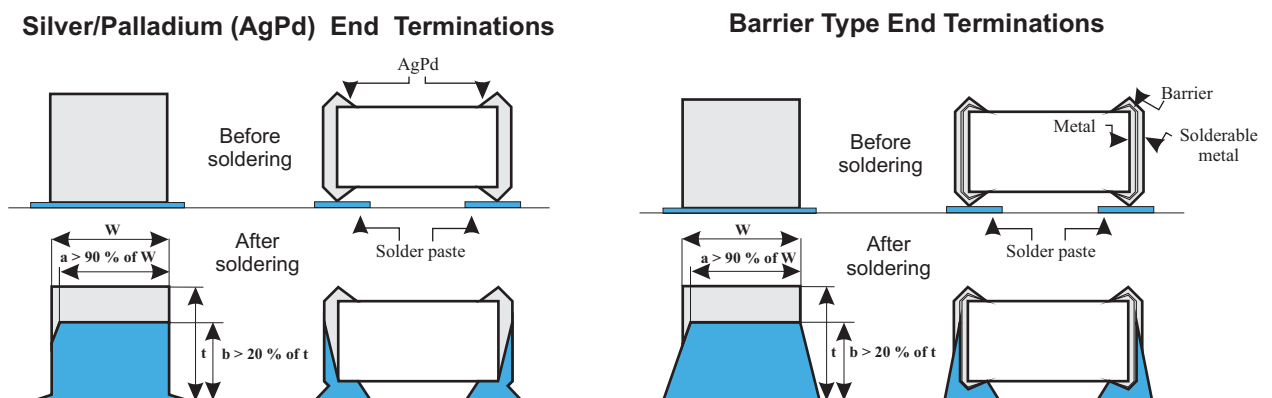


Fig. 5. Soldering Criterion in case of Wave and IR Reflow Pb-free Soldering

Pb-free Wave and IR Reflow Soldering - typical “before” and “after” soldering results for Silver/Palladium (AgPd) and Barrier Type End Terminations are given in Fig. 5. Barrier type varistor terminations provide standard meniscus and are recommended for Pb-free soldering.

A phenomenon known as “mirror” or “negative” meniscus results will appear in case of Silver/Palladium terminated varistors. Solder forms a metallurgical junction with the entire volume of the end termination, i.e. it diffuses from pad to end termination across the inner side, forming a “mirror” or “negative” meniscus. The height of the solder penetration can be clearly seen on the end termination and is always higher than 30% of the chip height.

Since barrier type terminations on KEKO-VARICON chips do not require the use of problematic nickel and tin-alloy electroplating processes, these varistors are truly considered **environmentally friendly**.

Solder Tests and Retained Samples - reflow soldering test based on J-STD-020D.1 and soldering test by dipping based on IEC 60068-2 for Pb-free solders are performed on each production lot as shown in the following chart. Test results and accompanying samples are retained for a minimum of two (2) years. Solderability of a specific lot can be checked at any time within this period should a customer require this information.

Test	Resistance to flux	Solderability	Static leaching (simulation of Reflow Soldering)	Dynamic leaching (simulation of Wave Soldering)
Parameter				
Soldering method	dipping	dipping	dipping	dipping with agitation
Flux	L3CN, ORL0	L3CN, ORL0, R	L3CN, ORL0, R	L3CN, ORL0, R
Pb Solder	96,5Sn / 3,5Ag			
Pb Soldering temperature (°C)	235 ± 5	235 ± 5	260 ± 5	235 ± 5
Pb-FREE Solder	Sn96 / Cu0,4-0,8 / 3-4Ag			
Pb-FREE Soldering temperature (°C)	250 ± 5	250 ± 5	280 ± 5	250 ± 5
Soldering time (s)	2	2	10	> 15
Burn-in conditions	Vdcm _{ax} , 48 h	-	-	-
Acceptance criterion	dVn < 5 %, Idc must stay unchanged	> 95 % of end termination must be covered by solder	> 95 % of end termination must be intact and covered by solder	> 95 % of end termination must be intact and covered by solder

Rework Criteria Soldering Iron - unless absolutely necessary, the use of soldering irons is NOT recommended for reworking varistor chips. If no other means of rework is available, the following criteria must be strictly followed:

- Do not allow the tip of the iron to directly contact the top of the chip
- Do not exceed the following soldering iron specifications:

Output Power:	30 Watts maximum
Temperature of Soldering Iron Tip:	280 °C maximum
Soldering Time:	10 Seconds maximum

Storage Conditions - SMD varistors should be used within 1 year of purchase to avoid possible soldering problems caused by oxidized terminals. The storage environment should be controlled, with humidity less than 40% and temperature between -25 and 45 °C. Varistor chips should always be stored in their original packaged unit.

Where varistor chips have been in storage for more than 1 year, and where there is evidence of solderability difficulties, KEKO-VARICON can “refresh” the terminations to eliminate these problems.