Guidelines for Vishay Sfernice Resistive and Inductive Components

Caution: Information included in product datasheets are leading to the general information given in this Application Note

1. STORAGE RECOMMENDATION

1.1 General Recommendation

Careful attention must be paid when the components are stored before usage. Because high and very low environmental temperature, high humidity, corrosive gases, etc. might affect the solderability of the terminals and the function of the package. Listed below are notes to be observed:

- The recommended storage conditions are in between 10 °C and 25 °C (room temperature) at a relative humidity in between 35 % and 75 %.
- Do not store them within the vicinity of any corrosive gases such as hydrogen sulphide, sulphurous acid, chlorine or ammonium. The oxidation of the metals caused by such toxic gases may affect solderability as well as the electrical and mechanical performance of these products.
- Exposure to the direct sunlight and dust must be avoided.
- Handle carefully to avoid deformation of terminals or degradation of component.
- Avoid direct contact between hands and parts.
- Keep parts in the original packages until just before use, and unpack only the quantity needed. Always seal any opened packages to protect them from oxidation and contaminants.

1.2 Moisture Sensitive Level (for SMD only)

Moisture Sensitivity Level (MSL) related to the packaging and handling precautions. During the storage of the device, humidity can be absorbed inside the molding element. Devices are more and more smaller. These smaller devices can be damaged during reflow when moisture trapped inside the component expands. This internal package stress can create some cracks or delaminations in the device. This is known as the “popcorn” effect. Most of this damage is not visible on the component surface. In extreme cases, cracks will extend to the component surface.
IPC/JEDEC has defined a standard classification of moisture sensitivity levels (MSL). MSL are expressed in numbers, with the MSL number increasing with the vulnerability of the package to popcorn cracking. Thus, MSL1 correspond to packages that are immune to popcorn cracking regardless of exposure to moisture, while MSL5 and MSL6 devices are most prone to moisture-induced fracture.
Table below presents the MSL definitions per IPC/JEDEC's J-STD-20.

MSL LEVEL	FLOOR LIFE	
	TIME	CONDITIONS
1	Unlimited	≤ 30 °C/85 % RH
2	1 year	≤ 30 °C/60 % RH
2A	4 weeks	≤ 30 °C/60 % RH
3	168 h	≤ 30 °C/60 % RH
4	72 h	≤ 30 °C/60 % RH
5	48 h	≤ 30 °C/60 % RH
5A	24 h	≤ 30 °C/60 % RH
6	Time On Label (TOL)	≤ 30 °C/60 % RH

Caution:
If any special storage conditions are applied (outside those recommendations), it is the users responsibility.

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1.3 Electrostatic Discharge (ESD)

The application of a high voltage and low current to a device as a result of its coming in contact with or in proximity to a charged object. In very dry climates, charges build up on any moving object including people. These charges pass to any object or electrical ground when the charged body comes into proximity with the uncharged body. Thus the device is said to be ESD sensitive if this passage of charge in any way does harm to the device.

This is the case for some Vishay Sfernice products. In such case, during manufacturing process, Vishay Sfernice takes appropriate disposition to avoid any risk of Electro Static Discharge. Packaging is either antistatic or low conductivity. Vishay Sfernice recommends to keep parts in original packaging until just before use.

Specific measures to reduce failures due to ESD to a minimum should be taken during storage of ESD sensitive components:
Keep components in antistatic protection (bags, strips, conductive foams).
Metallic rack connected to ground.
Component storage in antistatic containers.
Protection of the conditioning/deconditioning stations (straps, working surfaces, dissipators, etc.).
Arousing awareness to ESD problems of the operators in charge of conditioning/deconitioning the components and managing the stock.
Destocking should be performed maintaining the continuity of the above conditions.

1.4 Storage Duration

Products do not degrade with time and are expected to perform satisfactory for many years if stored in the recommended conditions described above.

In case of any doubt about storage conditions or after a long periode, we recommend to test the solderability before use.

2. GENERAL SOLDERING RECOMMENDATION FOR THROUGH HOLE OR SMD COMPONENTS

General Caution:
All the following information is based on our knowledge and has to be qualified by users.

2.1 Flux and Solder Recommendation

For SMD and through hole components, it is always advisable not to use a flux of an activity level greater than that necessary to achieve optimum yields for solder wetting. It is advisable that all types of fluxes be removed by cleaning due to the possibility of corrosion, without any mechanical and chemical degradation of products.

Suggested solder composition is:

- Tin lead solder: Sn63/Pb37
- Lead (Pb)-free solder: Sn96.5/Ag3/Cu0.5

Caution:
Flux should be applied on cleaned surfaces (avoid grease).
Avoid highly activated fluxes.

2.2 Soldering recommendation

Normal preheating is required to activate flux and minimize thermal shock to components. The maximum recommended temperature and duration for flow and reflow soldering profiles are specified below. It is important to note temperature of those profiles corresponds to parts temperature (and not PCB temperature). The use of leaded solder process or lead (Pb)-free solder process is specified under each series of SMD or through hole products.

General caution:
User must always test and verify pre-heating and soldering processes as well as other production line assembly before final production.

For precision resistors, a too high temperature during soldering process may affect performances.

Soldering iron caution:
Use the appropriate soldering iron size, shape and heat capacity for soldering all type of component. Do not exceed the maximum time and temperature parameters specified: 3 s at 350 °C. Never touch the body of the components with the soldering iron.

We recommend grounded iron.

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2.3 Recommendation for cleaning after soldering

Caution:
Refer to protection level of component (see §4).

Cooling down time after soldering and before exposure to defluxing solvents is required. The component body temperature when exposed to cleaning should not exceed 35 °C. Cleaning spray rinse is recommended with pressures of not greater than 60 psi (5.5 kg/cm^2) for a period not to exceed 15 s to 20 s.

Possible defluxing solvent/aqueous:

- Aqueous detergent solutions
- Terpene based semiaqueous
- Ester/ether based solvents
- Methanol/isopropyl alcoholic
- HAS

Caution:

- Avoid using cleaning solvents such as trichlorethane or freon which endanger the environment
- Ultrasonic may cause component damage or failure
- Solvents containing methylene chloride or other epoxy solvents should be avoided since these will attack the epoxy encapsulation material of some components.

2.4 Reworking recommendation

- **General caution:** Excessive and/or repeated high temperature heat exposure may affect component performance and reliability.
- **Recommended:** One rework maximum. Hot air reflow technique is the safest method for SMD component.
- **Caution:** Avoid use of a soldering iron or wave soldering as a rework technique.

2.5 Backward and forward compatibility

Component with SnPb or lead (Pb)-free alloys termination finishes can be soldered using SnPb or lead (Pb)-free soldering processes providing the temperature is suitable enough at component level.

2.6 Special warning for multiturn trimmers

It is important to note before pre-heating and soldering of multiturn trimmers, make sure the position of the wiper is not in contact with the end terminals (beginning or end of the wiper mechanical travel) to avoid malfunction of trimmers.

Adjustment of components should be done only after part has reached ambient temperature and cleaning solvent has evaporated (10 min).

3. GUIDELINES FOR SURFACE MOUNTING COMPONENTS (SMD)

Most of Vishay Sfernice SMD is designed to withstand the process related to infrared, hot air, vapour phase reflow and dual wave soldering.

3.1 Adhesive application

When an assembly has to be wave soldered, an adhesive is essential to bond the SMDs to the substrate. Under normal conditions reflow, soldered substrates do not need adhesive to maintain component orientation, since the solder paste does it. The amount of adhesive, the curing time and temperature to use should be in accordance wih adhesive manufacturer's recommendations. Otherwise, the adhesive polymerization time and temperature have also respect component soldering recommendations.

Caution:
The height and the volume of adhesive dots applied are critical for two reasons: The dot must be high enough to reach the SMD, and there must not be any excess adhesive, since this can pollute the solder land and prevent the formation of a good soldered joint.

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3.2 Reflow solder process

Solder paste:
Care should be exercised in selecting the solder paste. The metal purity should be as high as practical. The flux (in the paste) must be active enough to remove the oxides formed on the metallization prior to the exposure to soldering heat. In practice this can be aided by extending the solder preheat time at temperatures below the liquidous state of the solder.

Soldering:

Two reflow processes are commonly used, vapor phase and infrared reflow. Both reflow solder processes require the application of solder paste prior to component placement.

The thickness, related to the surface of the pad, determines the quantity of solder which will form the joint during the reflow. The reflow has to be sufficient to obtain an ideal solder fillet at a 45° angle.

The vapor phase reflow solder process uses flourcarbon liquids, boiled to produce a vapor saturated atmosphere, at a temperature slightly higher than the boiling point of the liquid and high enough to reflow the solder.

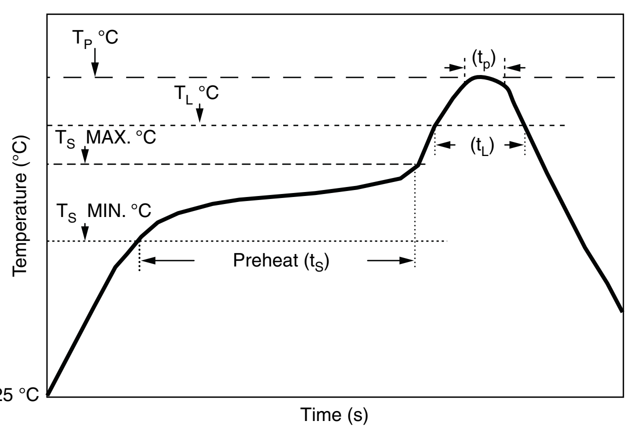
The infrared reflow solder process uses heat energy produced by an infrared radiation source and by convection (natural or forced). In such a system, the heat time is dependent of the absorption coefficient of the material surfaces and of the thermal mass of all the components in relation of the surface available to the infrared radiation.

The temperature of the components in an infrared oven is not precisely defined and temperature measurements should be taken on the component themselves when they are going through the oven. The temperature of small components may reach + 260 °C when they are soldered at the same time as larger ones.
The parameters which act on the temperature of the components are:

- Time and power
- Mass of the component
- Size of the component
- Dimensions of the substrate
- Absorption coefficient of the surfaces
- Density of the components
- Wave length of the radiation source
- Ratio between radiated energy and convection energy

A standard profile of this process is given in the graph shown:
A preheat period is necessary for the evaporation of all the volatile solvents contained in the solder paste before the action of the flux. It initializes the action of the flux on the solder and also on the metallic surfaces of the component terminations and substrate.

REFLOW SOLDER STANDARD TEMPERATURE PROFILE



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RECOMMENDED REFLOW PROFILES												
PROFILE [1]	T_p lead (Pb)-free	T_p Sn/Pb	t_p	T_L lead (Pb)-free	T_L Sn/Pb	$T_{S\ min.}$ lead (Pb)-free	$T_{S\ min.}$ Sn/Pb	$T_{S\ max.}$ lead (Pb)-free	$T_{S\ max.}$ Sn/Pb	t_S lead (Pb)-free	t_S Sn/Pb	t_L
1	230 °C	225 °C	10 s	219 °C	183 °C	150 °C	100 °C	200 °C	150 °C	60 s to 150 s	60 s to 120 s	60 s
2	245 °C	225 °C	10 s	219 °C	183 °C	150 °C	100 °C	200 °C	150 °C	60 s to 150 s	60 s to 120 s	60 s
3	260 °C	225 °C	10 s	219 °C	183 °C	150 °C	100 °C	200 °C	150 °C	60 s to 150 s	60 s to 120 s	60 s

Note

[1] For applicable profiles of components, please refer to product datasheets

T_p: Peak profile temperature, is defined as a user maximum
t_p: Time at peak profile temperature, is defined as a user maximum
T_L: Liquidous temperature
t_L: Time at liquidous
$T_{S\ min.}$: Temperature minimum preheat
$T_{S\ max.}$: Temperature maximum preheat
t_S: Time from $T_{S\ min.}$ to $T_{S\ max.}$

Infrared soldering caution:

If the infrared radiation is the heat source, the temperature increase of the SMD component should be carefully checked because the radiation absorption rate depends on the color and the structure of the material of component.

Recommendation:

In case of a double side mounting, do not clean the substrate after the first pass. This may include a high humidity level which will affect the quality of the solder during the second pass through.

Minimal solder fillets are always preferable. Solder paste should not creep very high on the terminations.

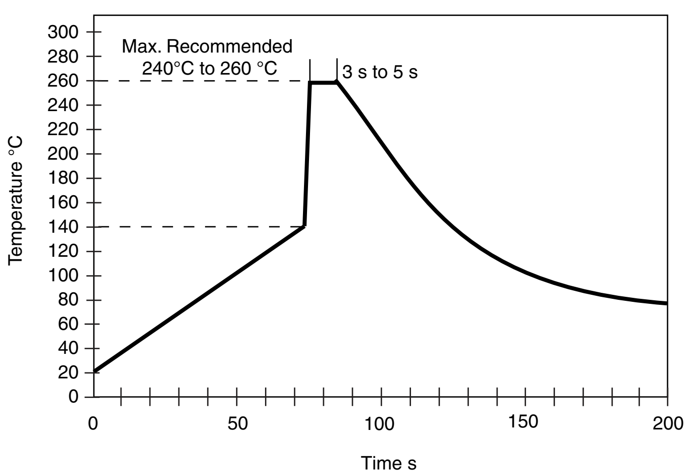
Good fillets are produced by a good wetting of the terminations (verify the angles resulting from wetting).

The mechanical adhesion of the part on the substrate is primarily produced by the solder of the terminations directly in contact with the substrate.

Acceptation criteria: If needed please refer to IPC-A610D according to class grade.

3.3 Wave soldering process

The soldering of surface mount components requires the use of a wave which insures sufficient flow of the solder between the components and which, however, minimize solder fillet and bridging. The graph indicates a standard temperature profile used in this process:



Caution:

Never exceed 260 °C, this will cause irremediable damages.

APPLICATION NOTE

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Recommendation:
Do not use a standard wave normally used for boards with leaded components. These waves are not optimized for solder boards with surface mount components.

The temperature gradient between preheat and wave soldering must be smaller than + 100 °C.

Terminations must go through the wave simultaneously.

4. IP CODES DEFINITION

IP codification as described here under represents the level of protection of a part against solid or liquid stress. Example IP67: Digit 6 dust tight; digit 7 protected against the effect of temporary immersion in water.

DEGREES OF PROTECTION PROVIDED BY ENCLOSURES - IP CODES DEFINITIONS

FIRST CHARACTERISTIC NUMERAL	DEGREE PROTECTION	
	BRIEF DESCRIPTION	DEFINITION
0	Non-protected	-
1	Protected against solid foreign object of 50 mm diameter and greater	The object probe, sphere 50 mm diameter shall not fully penetrate (1)
2	Protected against solid foreign object of 12.5 mm diameter and greater	The object probe, sphere 12.5 mm diameter shall not fully penetrate (1)
3	Protected against solid foreign object of 2.5 mm diameter and greater	The object probe, sphere 2.5 mm diameter shall not fully penetrate (1)
4	Protected against solid foreign object of 1 mm diameter and greater	The object probe, sphere 1 mm diameter shall not fully penetrate (1)
5	Dust-protected	Ingress of dust totally prevented but dust shall not penetrate in a quantity to interfere with satisfactory operation of the apparatus or to impair safety.
6	Dust-tight	No ingress of dust

Note
(1) The full diameter of the object probe shall not pass through an opening enclosure

DEGREES OF PROTECTION PROVIDED BY ENCLOSURES - IP CODES DEFINITIONS

SECOND CHARACTERISTIC NUMERAL	DEGREE PROTECTION	
	BRIEF DESCRIPTION	DEFINITION
0	Non-protected	-
1	Protected against vertically falling water drops	Vertically falling water drops shall have no harmful effect
2	Protected against vertically falling water drops when enclosure titled up to 15°	Vertically falling water drops shall have no harmful effect drops when the enclosure is titled at any angle up to 15° on either of the vertical.
3	Protected against spraying water	Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effect
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effect
5	Protected against water yets	Water projected in jets against the enclosure from any direction shall have no harmful effect
6	Protected against powerful water jets	Water projected in powerful jets against the enclosure from any direction shall have no harmful effect
7	Protected against the effects of temporary immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water under stabilized conditions of pressure and time
8	Protected against the effects of continuous immersion in water	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions which shall be agreed between manufacturer and user but which are more severe than for numeral 7