Vitronics Soltec

Information Sheet 004

By G. Schouten

Preheating of PCB's

General

Preheating is necessary to condition the flux by evaporating the flux solvent. In the case of wave soldering of SMD's it may be necessary to preheat to relative high temperatures to diminish the thermal shock for heat sensitive components.

Fluxing

The flux which is used in a soldering process is applied by foam, wave, spatter or spray fluxing. To apply the flux by means of these methods, means that the flux must be a liquid. This means that the active solids, such as colophony, are dissolved in a solvent, to make flux a liquid. In the soldering process however, we need only the solid parts of the flux. Although these parts behave like a liquid because they are above their melting point during soldering, no solvent may be present during the soldering process. If the flux contains still solvent at the moment the printed circuit board is entering the wave, we can expect soldering problems. These problems occur due to the fast evaporation of the remaining solvent if the board enters the solder wave.

Most of the time, the flux solvent is an alcohol having a boiling point of about 79°C. If this alcohol comes into contact with a solder wave of 250°C, the quick evaporation of the solvent will blow solder particles around. Also part of the flux will be washed off from the board by the solder wave, since it is impossible for the flux to adhere to a vapour layer because there is no adhesion between the flux and a vapour layer.

A good predrying is achieved when the solvent is evaporated out of the flux layer. For alcohol containing fluxes this means that at the end of the predrying stage, the temperature of the flux layer must be somewhat over 80°C. More predrying will give a higher board temperature, but can also activate the flux at a stage where it is spilled, because we need the flux to be active in the solder wave and not before. When more preheating is demanded one must choose an appropriate flux for the best solder result.

So the main goal for the preheating is to predry the flux, to evaporate the solvent from the flux using as little energy as possible. A new group of so called low solid content fluxes may demand a predry temperature of 100 - 120° C to give optimal soldering results. These types of fluxes are commonly used with boards containing SMD's on the solder side.

Thermal shock

What about preheating to prevent the thermal shock to the printed circuit board?

Often it is told that preheating is also necessary to prevent the thermal shock to the printed circuit board.

During the predrying of the flux, the board temperature will also rise and in this way the thermal shock during soldering is diminished. However, this is of minor importance since the bare PCB material must be able to withstand a 10 seconds floating test on a solder bath at 260°C directly from room ambient temperature.

After this float test the electrical and mechanical properties of the board must be the same as before this test procedure. So, a thermal shock is not a problem for the board material. Also SMD components are tested to their capability to withstand the thermal shock during the soldering treatment under the same test conditions. Some component manufacturers have, however, limitations for some components. In such cases a higher predry temperature, up to 130° C may be demanded, together with a relatively low soldering temperature 230° - 235°C.

With our special high intensity preheating it is possible to fulfil these demands.

Conventional leaded components

For the conventional components it is important to reduce the thermal load as much as possible, to prevent them from thermal damage. Sometimes heat sensitive components can be mounted on a spacer so that the distance between component body and solder joints is increased. This will give a lower inside temperature in the component body during the soldering process.

Care must be taken for such components if topside preheating is demanded.

Sometimes topside preheating is used to promote the solder flow in plated through holes especially in multi-layer boards. We believe that this may give a solution for boards which have no optimal thermal solderability.

However, if a board is well designed and has a good solderability, reliable solder joints will be formed using a dwell time of approx. 3 s at 250°C, using Tin-Lead solder. If the design does not make this possible than, as an alternative, it could be a good solution to enlarge the dwell time in the solder wave instead of putting more heat into the board by using a topside preheating.

The reasons are:

1. Solder gives a much better heat transfer than radiation does,
2. Conventional components can withstand a resistance to soldering heat for 10 seconds at 260°C if the heat is transferred via the leads and not directly generated to the component body as topside preheating will do.

Preheating systems

Almost all preheating units use a kind of radiation and or convection preheating system.

Radiation heat comes from infra red radiation. With shorter IR wave lengths, such as with lamps or quarts tubes, the IR radiation behaves more or less like light. This means that the main part of the heat is going through the transparent flux layer into the PCB and so will not directly dry the flux. For flux predrying, it is important that the heat is directly generated to the flux layer. For that purpose a long wave IR heating with hot plates or calrod elements is preferred. With such a heating system, also convection by heated air will help to evaporate the flux solvent. Forced hot air is not advised for predrying the flux, since this can lead to a dry skin on the outer side of the flux layer which will encapsulate the remaining solvent underneath. This problem normally only occurs with high solid content fluxes, which are sensitive to skin formation.
For fluxer with a low solid content (<10%) the forced predry system is however very effective.
For preheating SMD components also the use of infrared lamps and or quartz tubes may be used. They can quickly transfer relatively large heat energies to the SMD components, so increasing their temperature to the demanded level.