Quieting the Noise

Quality wave soldering depends on control of its many parameters.

The wave solder process is characterized by a large number of process parameters. To understand them all and their interactions is challenging, particularly when it comes to lead-free soldering. Wave soldering has a number of sub-processes, which include fluxing, preheating, soldering and cooling.

Although a good wave soldering machine provides a large number of parameters to optimize each application, the first requisite is good solderability, which requires clean surfaces to be soldered and a good thermal solderability of the assembly. The design of the assembly is a determining factor in successful soldering, as is the type of flux used.

The first parameter to consider is conveyor speed. Any change to the conveyor speed has consequences: It affects the amount of flux applied and influences the temperature profile after preheating. Changing the conveyor speed also affects contact time and cooling.

Currently, flux is applied with an atomizing spray nozzle in a closed system. Using a closed system eliminates flux density drift over time. The parameters in the fluxing process are large. Flux deposition is defined three ways: 1) by transfer speed of the nozzle, affecting spray pattern; 2) by atomization pressure of the nozzle, affecting droplet size of the flux; and 3) by the start and stop position, which defines where on the assembly flux will be applied.

The amount of flux is defined by the pump speed, or by the pressure on the vessel in the instance of a pressurized system. Within the parameters of the fluxer there are no interactions, only those to be considered in combination with conveyor speed.

The preheat sub-process can be done with a number of different heating configurations, including tubular Calrod elements, forced convection or an infrared lamp system. The preheat temperature will define the board temperature gradient and its temperature at the end of preheating. This is an important number when verifying flux activity. It will indicate whether the flux maintains the chemical strength that is needed on the solder wave. Again, preheat settings interact with the conveyor speed. Basically, if one changes conveyor speed, the settings of the preheat zones must be adjusted accordingly. Before any soldering is done, the board must reach the required temperature for the flux to do its job.

Soldering itself is mainly affected by two important parameters, solder temperature and contact time. Contact time is defined by a number of factors; these include conveyor speed, amount of solder in the solder pot, speed of the solder pump, type of wave former, height of the back plate and distance from the wave former to the bottom side of the assembly.

Between those parameters are many different interactions. Changing any of the settings of the aforementioned factors will immediately change the solder wave height and thus the contact time. For that reason, after any intervention (e.g., maintenance) a glass plate or similar diagnostic device must be run over the wave to verify that the contact time has not changed.

To reduce dross formation and optimize the soldering process, a nitrogen blanket system can be installed onto the solder pot. The amount of nitrogen that is purged over the wave is another parameter introduced with this option.

Diagnostics must be run after any intervention.

A cooling unit can be installed to cool the assembly after soldering. Operation of this unit will naturally affect the cooling gradient of the assembly.

Thus far, only the control factors of wave soldering have been discussed. But the various materials employed in the soldering process have significant effects as well. These include flux type, solder alloy and particulars of the assembly (board material, thickness, finish, thermal mass, etc.). These factors will not change during soldering unless the quality of the materials differs from batch to batch.

Apart from all these controllable factors, a wave soldering process is influenced by a number of noise factors. These include ambient temperature, exhaust conditions, humidity and more. Given all the possible parameters to consider in wave soldering, a proper process setup is thus required to produce high yields. Thermal profiling, defining contact time and attention to solder temperature must all be considered before a wave soldering process will succeed. Once all parameter settings are properly defined, refinement of process control parameters is necessary to eliminate noise factors that have the potential to disturb soldering quality, consistency and yields. ■

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