Why Not Ultrasonic Cleaning?

Many assemblers still shy away from using ultrasonic agitation to augment the cleaning power of various cleaning agents. This reluctance is due to fear of component damage that could come from use of single-frequency ultrasonic agitation of cleaning agents, back when TO-5 and similar metal-packaged semiconductor packages were widely used. Since much of this fear goes back 50 years, it is time to move ahead to meet today's cleaning challenges, such as the tenacious residues from lead-free and low-residue fluxes, combined with much higher reflow temperatures.

Laboratory Studies on Ultrasonic Cleaning

GEC-Marconi Ltd. led the way here, undertaking a broad range of studies under the project heading of "A Study on the Effect of Ultrasonic Cleaning on Component Quality." Multiple subsections of this study looked at different families of components and their survival when subjected to ultrasonic cleaning regimens. For a snapshot of power density (W/liter) vs. ultrasonic (U/S) exposure time (hours) that shows bands for efficient cleaning, no damage, onset of damage and severe damage, readers are referred to Figure 23, "Schematic Showing Damage Accumulation as a Function of Power Density and Exposure Time" in GEC Hirst Research Centre Report Number 17,295C. Based on these studies, component survival of 10X the anticipated ultrasonic cleaning cycle exposure time provides an adequate margin of safety.

Classic U/S Cleaning

Single-frequency U/S cleaning generally was performed with generators emitting 40 KHz for solvents and 25 KHz for aqueous processes. Post-cleaning testing for component survival was performed using measurement of component lead pull strength to failure and checking ball bond integrity within delidded components. Thus, articles on U/S often include such data. Lead in-tegrity checking continues to be the method of choice for U/S process evaluation, even as die leads change (i.e., both aluminum and gold, plus other alloys are used), component miniaturization continues, and new components are implemented.

Testing Components and Assemblies

The IPC Ultrasonics Task Group developed two test methods to determine the suitability of various components to ultrasonic cleaning. These are contained in the IPC-TM-650 Test Methods Manual.

Test Method 2.6.9.1, *Test to Determine Sensitivity of Electronic Assemblies to Ultrasonic Energy* determines if components will survive a cleaning cycle time of 10X the anticipated cleaning cycle time or 30 minutes, whichever is greater, when the components are soldered into a printed wiring assembly.

Test Method 2.6.9.2, *Test to Determine Sensitivity of Electronic Components to Ultrasonic Energy* determines if components will survive the same testing conditions when placed loose in a basket.

IPC/EIA J-STD-001C, *Requirements for Soldered Electrical and Electronic Assemblies* contains the following paragraph:

8.1.2.1, *Ultrasonic Cleaning*. Ultrasonic cleaning is permissible:

a. On bare boards or assemblies, provided only terminals or connectors without internal electronics are present.
b. On electronic assemblies with electrical components, provided the manufacturer has documentation available for review showing use of ultrasonics does not damage the mechanical or electrical performance of the product or components being cleaned.

These test methods were developed to provide manufacturers with standard test procedures necessary to comply with the need to supply test data on their cleaning methodology. The two test methods can provide data on components in the "as supplied" and soldered states. Unfortunately, J-001C does not call out these two test methods under Applicable Documents (Section 2). It is sincerely hoped this omission can be corrected in the D revision of J-001, hopefully within this calendar year. Readers will note that all the work to date has validated the GEC-Marconi studies, which concluded that the components would survive a 10X cleaning time exposure to 10 W/liter of U/S energy.

Current Advances in U/S Cleaning

After all studies were completed, innovative U/S equipment suppliers designed new U/S drivers to provide a variable frequency throughout the cleaning medium. This innovation avoided the previous single frequency wavelength, which contributed to some of the damage seen earlier from the single-frequency harmonic waves. The variable frequency approach (often 40 ±3 KHz) changes before the leads can build up potentially damaging harmonics. In one medical application, a critical fine gold gauze was cleaned without any damage. This same gauze would have disintegrated when cleaned with the single-frequency U/S process. Thus, many delicate electronics assemblies can be quickly and effectively cleaned with the variable frequency process, enhancing reliability and reducing warranty costs.

William G. Kenyon, an SMT *Editorial Advisory Board member, is the president of Global Centre Consulting, 3336 Birmingham, Fort Collins, CO 80526. E-mail him at wgkenyon1@aol.com or call (970) 207-9586 or (970) 980-6373 with any questions or for additional details on the column content.*

Surface Mount Technology (SMT) October, 2004
Author(s) : William Kenyon