Optimizing Solder Volume Specifications for Class 3 Manufacturing
Manufacturing complex electronic assemblies is focused on precision and accuracy which requires understanding the capability performance at various steps of the process.

OPPORTUNITY

Solder paste inspection (SPI) systems, such as the Koh Young models employed by IEC, provide detailed feedback on key solder paste deposition parameters such as volume percentage, area percentage, paste height and paste position relative to the SMT pad. Lower and upper acceptability limits are needed for each parameter before these systems can be effectively used as a screening tool (i.e. to decide when to pass the PCB on to component placement and when to reject). Lower and upper specification limits are also needed when evaluating the process capability, Cpk, of a stencil printing process.

However, it is recognized that all component types are not created equal. Different component geometries have different solder volume requirements and different tolerances for variation. For example a typical 0.4 mm pitch ball grid array (BGA) can accommodate a different range of solder volumes compared to a 0.4 mm pitch gull wing device and an electronic assembly typically contains a wide variety of component types.

IEC Electronics performed an exhaustive study to experimentally determine the acceptable range of solder paste volume percentages for various component types, with the goal of deriving “global” lower and upper specification limits that could be applied to most products and component types.

OVERVIEW

IEC Electronics selected a commercially available test vehicle printed circuit board assembly (Figure 1) that contained a representative variety of component types including:

- BGA (0.4 mm, 1.0 mm, 1.27 mm pitch)
- Chips (01005, 0201, 0402, 0603, 0805, 1206)
- QFN (0.5 mm, 0.65 mm, 0.8 mm pitch)
- Gull Wing (0.5 mm, 0.65 mm, 0.8 mm pitch)
OPTIMIZING SOLDER VOLUME SPECIFICATIONS FOR CLASS 3 MANUFACTURING

FIGURE 1
Test vehicle assembly used for experiments

A corresponding stencil was designed to produce intentional variation in solder paste volume across each specific component type, as illustrated in figure 2 for a 1.0 mm pitch BGA.

FIGURE 2
Experimental aperture design pattern for a 1.0 mm pitch BGA

PCB’s were stencil printed using multiple IEC approved solder paste formulations and the actual solder paste volume at each pad was measured using a Koh Young SPI system. The components were then machine placed, reflowed and inspected by an IPC certified operator. X-Ray imaging, prism scope imaging and cross-sectional analysis were also performed in IEC’s Analysis & Testing Laboratory as illustrated in figure 3.

FIGURE 3(A)
X-Ray image of 0.4 mm pitch BGA with range of solder volumes by row.

The lowest solder paste volume percent that produced a sufficient solder volume was identified for each component type (lower specification limit) as well as the highest volume % that did not produce a solder bridge or excessive volume defect (upper specification limit).

Determining the minimum and maximum solder paste volumes, that produce acceptable solder fillets per IPC-A-610 Class 3 requirements, is a critical advantage for complex electronics assembly manufacturing.
SUMMARY

A range of acceptable solder paste volume percent was identified that was within the allowable range for each specific component type studied but wider than IEC’s normal measured process variation hence indicating good capability performance. These proprietary “global” limits were applied to all of IEC’s Koh Young SPI programs which provide an effective screening mechanism for misprinted boards. The specific volume percent limits for specific component types are used extensively in the process capability evaluation of stencil aperture designs.