Abstract

In this work a sinusoidal vibration test method with resonance tracking is employed for reliability testing of circuit assemblies. The system continuously monitors for changes in the resonant frequency of the circuit board and adjusts the excitation frequency to match the resonant frequency. The test setup includes an electrodynamic shaker with a real-time vibration control, resistance monitoring for identifying electrical failures of interconnects, and vibration logging for monitoring changes in the dynamic response of the assembly over time. Reliability tests were performed using both the resonance tracking sinusoidal test method and the traditional fixed-frequency method for assemblies, each consisting of a centrally mounted BGA device assembled with SAC305 solder. These tests show that the resonance tracking method gives more consistent failure times than the fixed frequency method. Failure analysis for the tested devices shows the primary failure mode is trace failure with evidence of solder fatigue. A finite element model, correlated with experimental modal analysis, is shown to accurately estimate the circuit board deflection estimated from the harmonic vibration data. This provides a means of estimating the stresses in the electronic interconnections while for accounting for the variability between test parts. These fine-tuned vibration measurement techniques and related finite element models provide the building blocks for high cycle solder fatigue plots (i.e., S-N curves).