LITISOLA

Lifetime Prediction of soldered electronic assemblies for space

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Executive Summary Report

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1. EXECUTIVE SUMMARY REPORT

The scope of the project was to develop a methodology that allows to predict the life time of the solder joints electrically connecting the component with the printed circuit board (PCB). The method would allow to perform risk assessment prior to the realisation and testing of the actual physical electronic assembly. It also easily allows for parameter sensitivity studies to explore improvements in the design and component selection before prototyping.

The method is based on using finite element modelling (FEM) which simulates the stresses and strains acting on the solder joints during temperature cycling. A viscoplastic material model is selected for the SnPb solder. The output of the simulations are creep strains in the solder joint. An empirical model translates these creep strains into a number of cycles to failure. This empirical model is in this project derived through simulating about 25 different cases for a chip scale package (CSP).

In order to validate the simulation approach, a test vehicle is designed and procured with three different components: R2010 resistors, two different QFN packages and one PBGA component. These samples were soldered on three different boards with different stiffness and thermal expansion.

For the test vehicles described above, the simulation methodology is applied. As input for the model, the thermal expansion and elastic modulus for the PCBs are measured as function of temperature. Also the in-plane and out-of-plane deformation is measured for the QFN and PBGA. The material properties for these components are adapted to have the same deformation values as the measurements. The creep strains are calculated for all cases and transformed into cycles to failure.

Up to 2000 thermal cycles between -55°C and +100°C are applied to the three different assemblies having QFNs, resistors and PBGA components. The resistors and QFNs daisy chains are continuously measured for electrical opens. After 500, 1000, 1500 and 2000 cycles, two PBGA assemblies are cross-sectioned to check the fractures in the solder joints.

Finally, the simulated life times are compared to the test results. For all packages, a good agreement is found regarding the location of the solder joint fractures. The prediction of the QFN and PBGA assemblies were successful and within the 25% accuracy which was the target of the project. The predictions for the resistors were underestimating the life time.

As general conclusion, the prediction method is promising and further research and refinement will be needed to reduce the mismatch between test and simulation based predictions. The refinement lies into more accurate deformation measurements of the components and also have some crack propagation features, in particular for chip components.