FOR THE WORKSHOP:

Ball Grid Array (BGA) Solder Joint Reliability & Process Technology

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PROPOSED B.G.A. TALK OUTLINE FOR THE LOG 2002 CONFERENCE

I. The trend towards BGA packaging

II. The need for modeling as a design tool

III. Review of attachment technology

IV. Design of experiments approach

V. The empirical setup, mechanical /electrical

VI. Thermal cycling results, data reduction

VII. Analytical model and correlation

VIII. Future activity and data reduction

ABSTRACT FOR THE PAPER:

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ABSTRACT

The proliferation of higher density packaging in the form of BGA carriers has led to the need for a better understanding of the potential reliability of the solder joint interconnection. Further complicating the issue is the move towards more commercial (plastic) components in traditionally higher reliability applications. Little information exists in the technical literature which thoroughly addresses the subject of reliability in a comprehensive format, including the typical combinations and permutations of substrates, component package styles, process / assembly techniques and rework.

In order to prepare for the conversion and use of BGA electronic packaging components in future designs, a project was undertaken to empirically evaluate the long-term reliability of these packages on various substrates. Evaluated were ceramic, plastic, and tape automated bond (TAB) BGA package styles on ceramic, polyimide, epoxy glass (G-10/FR 4), and Aramid® fiber constrained substrate boards. BGA package styles ranged from 196 I/O to 736 I/O. Substrates (circuit boards) were evaluated in both the unsupported state, and attached to various frames and heat sinks. Substrates and components were individually monitored for differential motion using strain gauges. The assemblies included the BGA packages soldered onto the various substrates and frame combinations, and were also strain gauged to determine the 'system' response, as well as the differences between individual component motion and component behavior at the assembled module level.

An analytical model is proposed based upon the empirical results in combination with the strain gauge data. Thermal cycling was used as the stress-inducing element for both the individual

components and the module level strain gauge monitors. Solder joint reliability was determined using electrical resistance monitoring in a dynamic mode. All BGA packages were internally wired and circuit board design allowed electrical measurement and monitoring of the package corners and center solder joints. The modules were cycled up to 1,100 thermal cycles while strain gauge and solder joint resistance data was collected at room, - 55 C, and + 85 C temperature endpoints, every 50 cycles. After cycling, modules were cross-sectioned to confirm solder joint stand-off height, joint quality (Q), and crack propagation. A set of twenty 1.44 Mbit discs of data were generated and initially analyzed to propose the analytical reliability predictive models for CBGA, PBGA, and TBGA solder joints. Packages and substrates included COTS components, and standard commercial packages. Standard processing techniques were applied in a real manufacturing environment, with the exception of re-work. A special re-work method was developed and documented for low temperature processing.

This paper presents a partial summary of the test results, the test methodology, and procedures, and a first pass at the development of the analytical models. Empirical results are discussed along with the strain gauge data. Considering the large amount of data collected, only summaries of selected data are detailed. Finally, the issue of lead free soldering will greatly impact this technology. A future study is proposed to address these concerns.

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