DfR Solutions
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Extreme Drop Testing

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Introduction

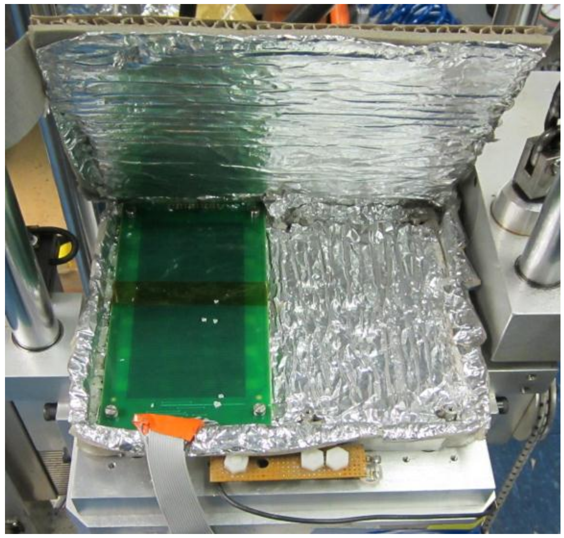
DfR Solutions was awarded two Phase II Small Business Innovative Research (SBIR) grants which was also leveraged into a parallel partnership program with nine companies. The two Phase II SBIRs and partnership program focus on testing the reliability of lead free components through drop testing and vibration testing. The testing specifications called for not only room temperature drop testing, but also drop testing at the temperature extremes of -55C and 125C. To obtain these temperatures during mechanical testing, specialized test fixtures needed to be developed for each temperature.

Experimental Procedure

All of the testing performed used the ANATech 256 STD series event detector to monitor the printed circuit board assemblies (PCBA) for failures. The ANATech allowed for multiple PCBA to be continuously monitored for increases in resistance. Changes in resistance indicated the presence of a crack along controlled impedance traces within the PCB, the components and the solder joints. The boards were dropped according to JESD22-B111 which states a failure criterion of a 10% increase in resistance. The ANATech was selected for resistance monitoring as it had a variable threshold resistance (set to the JEDEC standard) and the capability of sampling the boards every 200nS.

A Lansmont M23 drop tower was used for testing. Each board was mounted component side down to the 40lb aluminum drop block using ½" stainless steel standoffs. An accelerometer was also mounted on the aluminum drop block between the two boards. This allowed for accurate monitoring of the block's dropping force. A mechanical counter was attached to the block so that the drop each component failed at could be calculated.

The drop tower as shown was used for room temperature drop testing. This test set-up was modified for the extreme temperature drop testing. An insulated box was constructed then adhered to the aluminum block for the drop testing done at -55°C.



The PCBA was designed to include a controlled impedance trace throughout the PCB such that controlling the current flow through the trace would directly impact its thermal dissipation. An external controller circuit with a thermocouple feedback loop was designed to control the localized temperature of the board (set to 125C) and the components soldered to it.

Conclusion

In order to complete testing for these three SBIR projects, DfR Solutions created a unique solution for drop testing at extreme temperatures. This was achieved through creating an isolation box around the dropping plate and by designing a heating circuit in the PCBs. These solutions were necessary because there were no commercially available products that allow for holding a steady temperature, not room temperature, while actively drop testing. Testing at a variety of temperatures broadens the understanding of lead free solder joint characteristics with regard to mechanical behavior at common system operating temperatures. At cold temperatures, the modulus of the PCB laminate, the solder and components increase causes them to become stiffer. Decreased flexibility increases time to failure because more force is required to break solder joints at the same rate as at room temperature. As temperatures increase, the opposite happens - modulus decreases, boards become more pliable and time to failure decreases. This data can be used to build more accurate predictive models for most applications at variable temperatures.