

Prognostics of Electronic Interconnects

~ *Predicting Remaining Useful Life* ~

NPL is launching a new collaborative project and this document sets out a work plan and requests participating companies to forward contributions to NPL by the 30th July 2012.

BACKGROUND

In recent years the amount of interest in monitoring the health of a device and estimating its remaining useful life (RUL) has grown substantially. This new area is often termed 'prognostics'. Knowing when your assembly is going to fail can reduce downtime and maintenance costs for an application, by either allowing that device to remain in service longer between maintenance checks (e.g. aerospace sector), or replace it before it fails and costly downtime is involved (e.g. energy sector). Better understanding of an assembly's health can give the edge in a competitive market, allowing longer times between maintenance to be scheduled and a reduction in overall lifetime maintenance costs.

RATIONAL

There are many ways of approaching prognostics. Environmental logging of the temperature, humidity and acceleration can lead to an estimate of the accumulated damage in a device. If the amount of accumulated damage the device can take is known and is consistent, then this technique can work well. However, small differences in the processing, such as the solder paste printing consistency or reflow temperature profile can lead to circuit boards with significantly varying lifetimes. Monitoring some external parameter, such as the noise in the power line could also be used to give an indicator of the RUL of the device.



The approach considered in our research, therefore, will look at the interconnects themselves; measuring the electrical impedance, noise or linearity of the interconnect/component, and identify suitable indicators for predicting the RUL. Also the practicality of using lock-in thermography (LIT) will be trialled and the thermal map generated correlated to aging of the board and components. While not readily installed into systems LIT does offer a route to monitor specific areas of an assembly without intervening electrically.

Canaries were once used in coal mines to detect if the oxygen levels fell too far, as a warning for the miners to evacuate quickly. In the same way, canary components can be designed to fail before that of any other electronic component in a device and thus warn of the devices impending failure. This project will involve looking at a range of canaries, chosen or designed to fail earlier when exposed to harsh vibration or thermal cycling environments. In addition, electrical prognostics indicators on canaries themselves will be used to further resolve the RUL of the device.

OBJECTIVES

This project will develop a test protocol and methodology that will assist project partners in instigating techniques that will provide data on Remaining Useful Life. Interconnects in electronic assemblies have well recognised wear out properties. However interconnect performance is affected by specific materials and processes during manufacture, which can significantly alter lifetimes from the physics of failure models. Hence, the techniques developed in this project will allow asset owners to service their customer with the highest quality but with the minimum cost. Sustainment, planned maintenance, servicing and repair will be optimised.

WORK FLOW

- Review major interconnect failure mechanisms for harsh environments electronics.

- Identify electronic Indicators that give health and remaining useable life (RUL) of a solder based interconnect.
- Verification of indicators by measuring at different stages of accelerated aging - achieved through thermal cycling and vibration/fatigue using VPTI/IPTM machines developed at NPL.
- Develop mathematical model/algorithms to predict RUL.
- Design canary components and incorporate into test board.
- Measure canary component lifetimes from accelerated aging.

Role of Industrial Partners

This project will formulate an advisory group from which interested industrial partners will contribute to the financing of the project. In return the partners will be kept up to date with progress, attend 6 monthly meetings to discuss results and be involved in the overall decision making with regards to the direction of the project, and as to what components and conditions are included in the research.



What next

Following the meeting on 27th March here at NPL and this description of the work plan please forward your first year financial contribution of £5000+VAT to NPL to secure your participation in the project. We envisage a start date of 1st August.

We will hold a web conference meeting to discuss the project outline on 25th June at 4pm.

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A Gantt chart for this project is shown following.

