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Prognostic Health Monitoring Program for COTS at Sandia National Laboratories

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Prognostic health monitoring is emerging as one of the most important areas in military systems because it promises the ability to allow a system to diagnosis and report any faults or failures without the aid of maintenance personnel. It would also allow maintenance personnel to repair or replace systems or components before they break or at least be able to predict which parts are likely to break. The successful implementation of this concept would allow military systems to operate with greatly reduced failure rates and unscheduled downtime leading to a substantial cost savings. For this reason the US military has invested substantial resources in prognostic health monitoring for all types of systems. This abstract summarizes Sandia's work in the area of Prognostic Health monitoring for COTS electronic components.

Sandia has a number of unique capabilities including CMOS, optoelectronics, and MEMS fabrication facilities as well as design and characterization capabilities. Some of the devices that have come from these facilities include the advanced test chip and chemlab on a chip as well as other unique sensors that can record the storage and usage environments of COTS parts.

One of the main components of this center is Sandia's COTS insertion program. This effort has not only developed a methodology for purchasing and characterizing COTS parts but it also has developed a testing capability for electronic components. Some of these testing capabilities include: HALT chambers, HAST chambers, and thermal cycling chambers. Tools for evaluation of COTS include CSAM, SEM, FIB cross sections and a jet etcher for etching plastic packages.

Sandia also has a great deal of experience in the physics, modeling, and experimental verification of different failure modes. Some of this work includes: solder fatigue, moisture penetration and corrosion, solder aging, tin whisker growth, and the degradation of electrical contacts. The solder fatigue and moisture penetration work has detailed Monte Carlo models behind them so that the statistical rate of failure can be accurately predicted.

Sandia has long been active in the area of engineered evaluation structures such as the advanced test chip program. These devices allow us to take fully characterized devices that are particularly sensitive to failures through various testing conditions, thus allowing failure mechanisms and rates to be characterized with a higher degree of accuracy.

Finally, Sandia has also been active in the area of consequence engines and sensor driven diagnostics on complex military system as well as system level simulation and modeling tools. This work allows failures to be predicted and the impact on the rest of the system to be analyzed.

OUTLINE

Bringing together a group of dissimilar projects under a single banner

Why PHM

WRCIP

- COTS purchasing and evaluation procedures
- Burn-in, HAST, HALT, thermal cycling
- CSAM, SEM, FIB, other evaluation techniques

MOU

- Solder fatigue modeling and experiments
- Moisture penetration modeling and experiments
- Tin Whisker modeling and experiments
- Long term dormant storage that incorporates all of this models and experiments

Jeff B's

- Predictive aging models for components including
  - Solder aging
  - Corrosion
  - Electrical contact (in relays) modeling

Engineered aging/evaluation structures

- Jeff B developing Engineered aging structures
- ATC work

Jeff B environmental sensors

Jeff B built in self test

Bob Cranwell consequence engine

Bob's simulations of complex systems

Bob's modeling of bell shaped curve