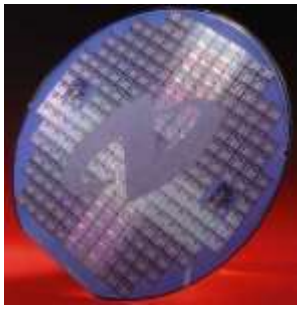
Annual Conference of the Prognostics and Health Management Society 2012
Sept 23 – 27, 2012

Panel Session
PHM Standards - IEEE PHM Standard

Sony Mathew

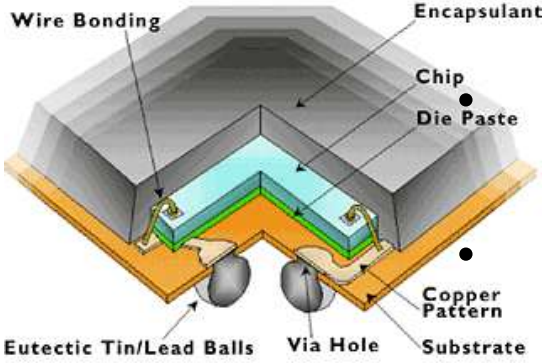
Center for Advanced Life Cycle Engineering
University of Maryland
College Park, MD, USA 20742
www.calce.umd.edu
www.prognostics.umd.edu

Electronics is Complex



- Level 0: on–chip
  - die and metallization
- Level 1: the part and package
  - resistor, capacitor, wirebond, lead frame and encapsulant

- Level 2: the circuit card assembly
  - circuit boards and solder joints



- Level 3: the box, chassis
  - hard drive, Line Replaceable Unit box

- Level 4: electronic product, system
  - notebook computer, field communications unit

- Level 5: Multi electronic systems
  - Aircraft communication, navigation and identification (CNI) systems, Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)

Examples of Failure Sites and Mechanisms in Electronics

Sites	Mechanisms
Die	Fracture/ Fatigue
Die Metallization	Corrosion/ Electro -migration/ Constraint Cavitations/ Bond Pad Fatigue/ Hillock Formation
Device	Slow Trapping/ TTDDB/ Surface charge spreading/ ESD/ Electrical Overstress/ Ionic Contamination
Device Interconnects	Wire Flexure Fatigue/ Shear Fatigue/ Intermetallic Formation/ Solder Joint Fatigue
Case (Hermetic// Plastic)	Loss of Seal/ Case Fracture // Delamination / Cracking/ Popcorning
Leads	Intermetallic Formation/ Solder Joint Fatigue
Substrate	Fracture/ Fatigue

Sites	Mechanisms
Attach	Fracture/ Fatigue
Package Interconnections	Low cycle fatigue/ High cycle fatigue/ Shock / Fracture
Printed Circuit Board	CFF/ Trace corrosion/ Trace fracture/ Fiber resin de-bonding/ Delamination, Lead pad corrosion/ Dendritic growth/ Laminate plasticization/ Intermetallic formation/ PTH barrel fatigue/ Electrical shorting due to tin whiskers.
Circuitry	EMI/ Crosstalk/ Signal Noise/ Signal Delay.
Connectors	Corrosion: Pin fretting or Finger fretting/ Spring relaxation

Challenges in PHM for Electronics (1/2)

- PHM not part of the conceptual design of the system.
- Intermittent Failures/ No Fault Found.
- Inadequate physics based models.
- Identification and selection of precursor parameters to monitor.
- Sensors for PHM. Availability and selection criteria.
- Algorithms for prediction. (Which algorithm is the best? What about uncertainties in the initial modeling of the system).
- Accounting for aging of systems. (Shift in normal behavior over a period of time/ usage).
- Integration of canary devices on host systems.
- Data fusion and fault isolation at the system-of-systems level.

Challenges in PHM for Electronics (2/2)

- Software-hardware interactions. How do you account for hardware failures caused by software glitches and vice-versa?
- Implementation at enterprise level.
- Changing the maintenance culture.
- Education: lack of trained professionals in PHM.
- Business Case: quantifying the cost of implementation of PHM vs maintenance savings.
- Regulatory issues.
- Lack of standards for PHM.

Need For A Standard

- No standardized definition of terms used in PHM.
- Researchers have developed a variety of approaches, methods, and tools that are useful for these purposes.
  - There is a lack of real visibility into these tools.
  - Lack of uniformity in application of these tools.
  - Lack of consistency in their demonstrated results.
- No clear compatibility and interoperability of PHM technology .
- Not easy to understand and compare different methodologies, algorithms and products related to PHM.
- There is a need for documented guidance that will encourage practitioners to invest the resources necessary to develop and put PHM techniques into practice.

IEEE Standard for PHM

- **IEEE Std. No.:** P1856
- **Title:** Standard Framework for Prognostics and Health Management of Electronic Systems
- **Type of Document:** Standard
- **Life Cycle:** Full Use
- **Working Group Chair:** Michael Pecht
- **Sponsoring Society and Committee:** IEEE Reliability Society/IEEE Reliability (RS/SC)
- **Working Group:** Prognostics and Health Management of Electronic Systems (RS/SC/PHM).

Scope

- This standard covers all aspects of prognostics and health management of electronic systems, including definitions, approaches, algorithms, sensors and sensor selection, data collection, storage and analysis, anomaly detection, diagnosis, metrics, life cycle cost of implementation, return on investment and documentation.
- This standard describes a **normative** framework for classifying PHM capability and for planning the development of PHM for a system or product.
- This standard provides **information** to aid practitioners in the selection of PHM strategies and approaches to meet their needs.

Purpose

- The purpose of this standard is to classify and define the concepts involved in prognostics and health management of electronic systems,
- and to provide a standard framework that assists practitioners in the development of business cases, and the selection of approaches, methodologies, algorithms, condition monitoring equipment, and strategies for implementing prognostics for electronic systems.

What We Intend the Standard to Do

- Provide a **broad overview** of PHM while at the same time provide significant details to assist the reader in making the appropriate decisions.
- The **standardization of definitions** of terms used in PHM of electronics.
- **Provide information** for implementation of prognostics and health management (PHM) for a complex system like electronics.
- Help manufacturers and end users **plan** the appropriate prognostics methodology to implement and the **anticipate** the associated life cycle operations for the system of interest.
- Provide practitioners with information that will help them **make business cases** for PHM implementation, **select proper health management strategies** and **performance metrics** to evaluate the prognostic results.

Our WG Members

- 110 WG members
- 17 countries
- 78 organizations