Advanced Microelectronic Component Engineering Principles and Practices

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Note to attendee: Class includes coffee and pastries in the morning and a full sit-down lunch at noon.

Class Time (8:00 AM - 4:00 PM)

COURSE SUMMARY

This is an updated full-day seminar focused on microelectronic components used in military, space, and other high reliability applications. Components include active integrated circuits (ICs) and monolithic microwave ICs (MMICs), ceramic and tantalum capacitors, thick/thin film resistors, various substrate materials, inductors, magnetics, filters, and other electronic components used and packaged as discrete devices or assembled in a hermetic or non-hermetic hybrid and multichip packages. The component engineer must understand the basic materials and processes used to build active and passive components and most importantly the reliability implications when choosing one part type or package configuration over others.

In addition to an understanding of the basic technology the component engineer must have a working knowledge of a myriad of specifications and issues needed to build or purchase quality components that work as advertised over the temperature range of interest (typically -55C to 125C) for the expected mission life of the system. In this full day seminar experienced experts in this field will review and explain in simple terms the following:

Intro by Tom Green (10 min)… couple of slides on CE vs EE salary !!

Component Engineering Functions (0815-0930)
Ron Demcko, Kyocera /AVX

- Military and alternate grade part specifications and quality standards
- Component Reliability Discussion
- Source Controlled Drawings vs ‘standard’ components
- When might SCD be used vs standard components, what makes a good SCD
- Harsh Condition Performance – radiation, transient voltages, high/ Low Temperatures
- Part failure mode discussion
- Size & Material Trends
- Case size, Mounting Area and Weight impacts of Miniature parts
- Distributed Electrical Models for Capacitors, Inductors and resistors
- Circuit simulation and modelling
- Summary of useful Links to NEPP, DLA, NASA, ESA, RoHS, ITAR

BREAK (9:30 AM - 10:00 AM)

Materials and Processes for Passive Components (10:00 AM – 12:00 PM)

Tantalum & Electrolytic Capacitors
Jerard Jose, VISHAY

- Capacitor construction and how performance characteristics are affected by time, temperature, voltage, and frequency.
- End applications are discussed along with reliability expectations, common failure modes and de-rating methods for increased lifetime performance.
- Processing guidelines and simulation models are presented.

Ceramic, Film, Stacked Modules and SuperCaps
Ron Demcko, Kyocera/AVX

- Performance characteristics are discussed relative to time, temperature, voltage, and frequency. Distinctions are made between thin film capacitors and power film capacitors.
- Stacked capacitor modules - traditionally MLCC (multilayered ceramic capacitors)
- Super capacitor technology overview, super capacitor modules.
- A high-level selection guide and de-rating methods is given for all capacitors presented.

LUNCH (12:00 PM - 1:00 PM)

Introduction and Overview of "Non-Hermetics" for Mil and Space (1:00 PM – 2:30 PM)
Tom Green, TJ Green Associates, LLC

- Terminology overview: PEMS, plastic parts, "non-hermetics"
- What is "non-hermetic" packaging and how is it different from traditional hermetic parts?
  - Cavity and non-cavity non-hermetic packages
  - Plastic package design considerations
- Drivers for lower cost high reliability plastic packages
  - Temp range, mission life, extreme environments and availability of advanced devices
- Military Specs applicable to non-hermetics
  - Microcircuits Class Y Space qualified microcircuits, Class P
  - Mil-PRF-38534 Hybrids Appendix D "non-hermetic" packages
  - Mil-Prf-19500 JEDEC Task Group on Non-hermetics
  - NASA COTS EEE parts
- Overview of Industry Specs for Qual of plastic parts
  - J-STD-020, AEC Q100/101
  - JESD47K Stress driven qualification
  - JESD22-A101/A102 and A110
  - Review of SSB-1
- Near- Hermetic Packaging Theory
  - Fick's law of moisture diffusion
  - Quasi Steady state model to predict moisture ingress

Stress driven Qualification for Non hermetic packaging

- Overview of electronic packaging reliability
  - JEDEC standards for package reliability
    - Moisture preconditioning (Moisture Sensitivity Level (MSL) with description of the solder reflow profile
    - High Temperature Storage
    - Highly accelerated stress test (HAST) and biased HAST
    - Temperature cycling
  - Failure analysis (scanning acoustic microscopy, cross-sectional analysis)
- Stress driven qualification for Plastic Encapsulated Microcircuits (PEM)
  - Overview of temperature humidity models
  - Determination of the expected lifetime using field use condition of -55 to 125°C

BREAK (2:30 PM – 3:00 PM)

DPA (Destruct Physical Analysis) (3:00 PM – 4:00 PM)
Trevor Devaney, Hi Rel Labs

- Rationale and testing protocols for performing a DPA per Mil-Std-1580
- Examples and what is learned from a DPA report
- Examples of failures

INSTRUCTOR BIOS

Thomas J. Green has more than 45 years combined experience in industry/academia and the DoD. He earned a B.S from Lehigh University in Materials Engineering and an MEA from Univ of Utah. He is a recognized expert in materials and processes used to assemble hybrids, RF microwave modules/5G, Class III medical implants, optoelectronics, and other types of hermetic/non-hermetic packaged microcircuits and sensors. He has considerable expertise in hermetic testing methods per TM 1014 and moisture related failures in general. He is a consultant to companies developing next gen microelectronics for military and space. Serving as a Research Scientist at the U.S. Air Force Rome Air Development Center, Tom worked as a reliability engineer analyzing component failures and in industry, he was the process engineer at Lockheed Denver. He has invaluable experience in wirebond, die attach, hermetic sealing, FA and root cause identification, For the last 25 years, Tom's expertise has helped position TJ Green Associates, LLC as a recognized industry leader in teaching and consulting services for high-reliability military, space, and medical device applications. Tom is a Fellow of IMAPS (International Microelectronics and Packaging Society) and retired LtCol USAFR with 28 years of service.

Ron Demcko graduated in 1982 from the Clarkson College of Technology BSEE. He is currently an AVX Fellow and manages TSG team at AVX Headquarters in Fountain Inn SC. This role centers on projects ranging from simulation models for passive components to product support / new product identification & applied development. Prior to that, Ron was the EMC lab Manager AVX Raleigh N.C. This lab concentrated on sub assembly testing and passive component fixes for harsh electrical and environmental. Before the EMC lab work, he held an Application Engineering position at AVX Product work included integrated passive components, EMI filters and Transient voltage suppression devices. Before joining AVX he worked as a Product Engineer and later Product Engineering Manager at Corning Glass Works electronics division. In this role he supported production, sale and development of Pulse Resistant Capacitors, High Temperature Capacitors and radiation resistant capacitors. He developed high frequency test methods and co-developed high temperature test systems.

Trevor Devaney has been President of Hi-Rel Laboratories, Inc. for the last 21 years and has been involved in DPA Testing, Materials Analysis, and Failure Analysis of electronic components and for 41 years. He has a BSc. In Metallurgical Engineering from Cal Paly San Luis Obispo. He has been highly contributive to the development of Industry testing specifications such as Mil-Std-1580 Revisions A, B, and C respectively, as well as various Mil-Std-883 and 750 test methods over the last 30 years. Trevor is an ardent supporter of educating the newest generation of component engineers for the Space and Hi-rel industries. Trevor has been an annual presenter at SPWG for the last 21 years and routinely lectures on DPA findings and techniques on a regular basis.

Jerard Jose holds a Bachelors of Science in Electrical Engineering from the University of Central Florida. With over 14 years of experience in passive components, primarily in capacitor technologies including tantalum, film, MLCC and aluminum dielectrics. Focus on tantalum capacitors for high reliability applications of aerospace, defense and space markets. Current role at Vishay Intertechnology Inc. as Senior Marketing Product Manager in the Capacitors division of tantalum, MLCC & aluminum.