12. Reliability Engineering Testing Methodology and Statistical Knowledge for Qualifications of Consumer and Automotive Electronic Components

Course Leader: Fen Chen (GM Cruise)

Course Description:

Consumer electronics industry and today's fast-growing automotive industry continue to demand ever-higher product hardware reliability. This tutorial will provide an overview of reliability testing methodology and statistical knowledge for qualifications of consumer and automotive electronic components. The reliability testing management including various Rel testing methods and its application to product development at different phases will be first introduced. Some important statistic/probabilistic concepts including uncertainty, confidence level, and how to minimize/deal with them will be discussed. An effective approach to mitigate low sample size and short test duration will be introduced. Then the tutorial will focus on physics of failure-based acceleration life models for some common Rel testing failures. A deep dive discussion on temperature cycling model considering dT acceleration, dwell time acceleration, ramp rate acceleration, and Tmax acceleration will be explored. Next, a typical methodology to develop a PoF based Rel validation testing plan reference to product field mission profile will be introduced. The mission profiles of conventional vehicles and consumer smartphones will be compared. How to develop a customized mission profile for AV specifically per its deployment location will be described. Finally, some examples of hardware failure modes with their risk assessments and lifetime modeling will be presented.

Course Outline:

1. Reliability Engineering Product Qualification Methodology (Strategic Planning)
2. Reliability engineering general introduction
3. Knowledge-based and standard-based Rel qualification approach
4. DfR, Rel R&R, various Rel testing methods and their applications during product development
5. Reliability Engineering Basic Knowledge of Probabilities and Statistics (Statistics)
6. Rel testing uncertainty and how to minimize & deal with it
7. Common Rel engineering statistical concepts, methods, and usages
8. Reliability Engineering Acceleration Lifetime Modeling Overview (Physics of Failure)
9. Various life acceleration models for consumer products and automotive components Rel failures
10. Reliability Test Plan Development based on Mission Profile Overview (Standards, Knowledge and Experience)
11. Customized Mission Profile Development
12. GMW3172 based Rel validation plan for automotive electronic components
13. A company specific Rel validation plan for smartphone
14. Failure Modes and Lifetime Prediction Case Studies
15. Time-dependent parametric shift modeling of LED
16. LCD display dark spot failure mode deep dive
17. AV liquid cooling compute system coldplate buckling failure during high temperature degradation
18. Automotive roof module component 2D stress-strength failure rate determination for vastly distributed

Who Should Attend

Engineers and tech managers already involved in the consumer product and automotive product fields, and those who need fundamental understanding or broad overview of product Rel qualification

BIO: Fen Chen received his Ph.D. degree in Electrical Engineering in 1998 from University of Delaware. From 1997 to 1998, he was with Intel Component Research at Santa Clara, CA as a graduate intern working on IC interconnect reliability. He joined IBM microelectronics at Essex Junction, VT in 1998 and had worked on semiconductor technology reliability issues until 2015. From 2015 to 2019, he worked for Apple Inc at Cupertino, CA as a senior reliability engineer focusing on qualifications of various consumer electronic products. In 2019, he joined Lumileds at San Jose, CA as the director of quality and reliability and was responsible for qualifying novel uLED MCM products for automotive applications. After 6-month of work at Lumileds, he joined GM Cruise in 2019 as a senior staff reliability/validation engineer, and has been working on validations of electronic, optical, and electromechanical modules for groundbreaking Cruise AV hardware systems since then. He holds more than fifty-five patents and has published over 60 technical papers/invited talks on various journals and conference proceedings.