

Introduction to Worst Case Circuit Analysis For the Automotive Engineer

Course Overview:

This intensive course focuses on the fundamental skills required to perform a **Worst Case Circuit Analysis (WCCA)**. Participants learn the importance of this analysis as it relates to assessing functional hazards, circuit margin and risk assessment, and product development and testing. WCCA analysis methods and techniques are fully explored. Component tolerances for common electronic components are studied in depth. Methods of correlating models, including critical power supply testing techniques, are explored in a hands-on demonstration. Each class member is provided with a complete WCCA for a power supply and the opportunity to discuss aspects of interest in detail. The proper documentation formats for communicating the analysis results is explained with detailed examples allowing the participant to gain a full understanding of the methods, requirements and resources needed to complete a WCCA. The class is geared towards the Automotive Electrical Engineer and Manager.

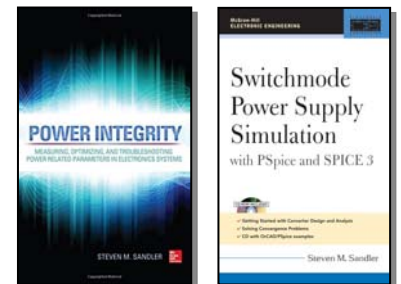
Learn firsthand from Steve Sandler (author and industry expert on Power Integrity) and Charles Hymowitz (WCCA SME), two of the top power electronics industry consultants. The course combines the teaching of theoretical and practical concepts and years of hands-on experience with tried and tested methodologies for improving your reliability analysis procedures. These WCCA techniques are accepted by virtually every aerospace and automotive manufacturer as the standards in the industry.

Benefits:

- Learn the value of WCCA in performing risk assessments of potential hazards
- How WCCA supports product development and safety requirements
- Understand when and to what extent a WCCA should be performed
- Define and maintain a global parts variability database
- Understand how to perform and document key WCCA analyses
- Be able to review and critique a WCCA
- Understand the difficulties in developing and correlating circuit models including obtaining test data

Key Program Topics:

1. Introduction to Worst Case Circuit Analysis
2. WCCA Methodologies for Validation and Verification
3. Component Tolerances
4. Knowing what to analyze and how to analyze it
5. Analog, Digital, and RF WCCA Checklists
6. Documentation and Essential Formats
7. Planning a WCCA – Timing, Costs, and Schedule Drivers
8. Navigating Ford's WCCA Guide
9. Reviewing a WCCA
10. Power Integrity and PDN Analysis
11. Testing Requirement for WCCA and Part Modeling
12. Handling EMC Transients - Immunity, ESD, Battery Transients
13. FMC1278 Stimulus Generation



Course Duration: 8 hours per day, 2 days

Course Materials:

- WCCA Workshop Handouts Book (300+ Slides and Notes pages)
- WCCA Workshop Examples Book (300+ pages)
- Additional Applicable Articles, Templates, and Source Materials
- Door Prizes - “Switchmode Power Supply Simulation with PSpice” and “Power Integrity” books

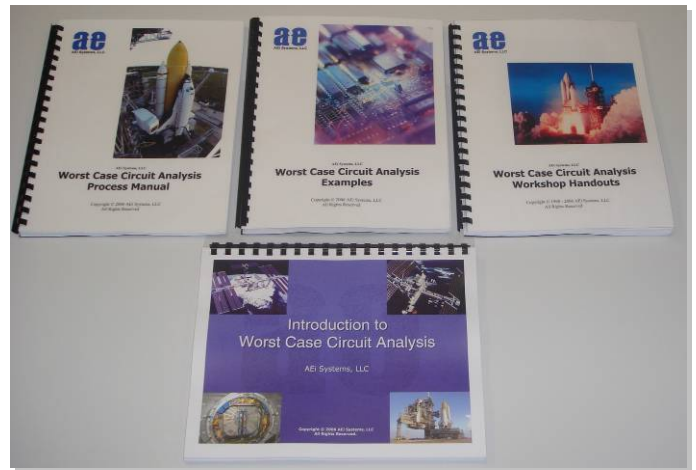
Course Instructor: Steve Sandler, Founder and Principal Engineer, AEi Systems

Mr. Sandler has over 35 years’ experience in the analysis of power conversion equipment for military and space applications. In his current position Mr. Sandler is responsible for worst case and power integrity analysis, reliability analysis, and FMECA analysis of satellite & power electronic systems.

Mr. Sandler is author of several books and numerous articles on power supply modeling and simulation including, “Switchmode Power Supply Simulation with PSpice”, “SPICE Circuit Handbook” and most recently “Power Integrity: Measuring, Optimizing, and Troubleshooting Power Related Parameters in Electronics Systems.” He has held positions with ST Keltec Corp., Telephonics Corp. Signal Technology, Aerospace Avionics Inc., and Lambda Electronics.

Mr. Sandler is a Best in Test, Test Engineer of the Year Finalist (2012-2014) and winner of the Jim Williams ACE Contributor of the year award.

Mr. Sandler is the holder of US Patent Number 4,541,039, Magnetic Modulator, Sept. 1985. Mr. Sandler received his BSEE degree from Pacific Western University.



Assistant Instructor: Charles Hymowitz, AEi Systems, Managing Director

Mr. Hymowitz has over 30 years of experience in the Reliability, EDA software and analog/digital simulation industries. Mr. Hymowitz has been Chairman of AEi Systems, LLC since its re-organization in 2002. In 2012, Mr. Hymowitz was recognized as the only independent SME (subject matter expert) on Worst Case Analysis. Mr. Hymowitz was a key contributor to the creation of Aerospace Corporations’ industry guidelines (TOR-2013-00297) for WCCA. In 1985, Mr. Hymowitz co-founded Intusoft, a leading CAE/EDA software corporation where he was a Director and held several positions, including Vice President, Product Development and, most recently, Chief Operating Officer. Mr. Hymowitz created and edited the Intusoft Newsletter the industry standard SPICE publication. He has co-authored the “SPICE Circuits Handbook”, “Simulating with SPICE”, “The SPICE Cookbook”, and “The SPICE Applications Handbook.” Mr. Hymowitz is a graduate of the Rutgers University, with a BS degree in Electrical Engineering, and the Stanford University Executive Institute program for Management of High-Technology Companies.

2 Day WCCA Workshop Course Outline:

DAY 1

- 1. Introduction to Worst Case Analysis**
 - What is a WCCA?
 - Why do we do it?
 - When do we do it?
 - To what extent do we do it?
 - Who should perform it/Review it?
 - Using WCCA for Failure Analysis
 - How does WCCA Save Money
 - WCCA Costs and Scheduling
 - Where the most problems are found
 - Electrical test methods and limitations
- 2. WCCA Methodologies**
 - Methods of analysis
 - Sensitivity
 - Parametric EVA, RSS, Monte Carlo
 - Comparison of methods and templates
 - Tolerance Database Setup
 - Determining Critical Parameters
 - Dealing with Poorly Defined Tolerances
 - RSS Computations and Application
 - Example: Three Terminal Regulators
 - Correlating Hardware-WCCA Results
- 3. Part Tolerances and Variability**
 - Tolerance Database Structures
 - Calculating Tolerances
 - Aging Tolerances
 - Extrapolation (Arrhenius models)
 - Mean Shifts
 - Tolerances for Resistors, Capacitors, Diodes, Zeners, BJTs, Mosfets, Magnetics, Digital ICs, Analog ICs
 - Minimum Beta (hFE) Analysis
- 4. Planning a WCCA**
 - Planning a WCCA - What to Analyze
 - Complying with Standards
 - WCCA Task Description Pitfalls
 - Handling Compliance Requirements
 - What data do I need to get?
 - What will my WCCA Cost and How long will it take
 - Navigating the WCCA Guide Analysis List
 - Dealing with FMC1278 EMC Transients

DAY 2

- 5. Documentation**
 - Why is documentation important?
 - Formatting a report
 - What must be included in a report?
 - Example: Report
 - Reviewing a WCCA
 - Dealing with Non-Compliances/Design Changes
- 6. Analysis Tools and SPICE Modeling**
 - Digital, Analog, RF
 - SPICE Simulation Pitfalls
 - Modeling
 - Reviewing Vendor libraries
 - Modeling Basics and Pitfalls
 - What to look for in a vendor model
 - Solving Convergence Problems
- 7. Testing for WCCA/Model Correlation**
 - What and Where to Test
 - Problems with datasheets
 - Testing Components & Power Systems
 - Stability, PSRR, Load Step, Ripple
 - Non-Invasive Phase Margin
 - Choosing the Right equipment
 - Testing Distributed Power Systems
 - Testing PDN Impedance
 - Hands-on Demonstration
 - 3-Terminal Regulator; PDN, Switcher
- 8. Extended Topics & Examples**
 - Selected Examples
 - Regulator: EMC Transients, Stability, Startup, Inrush
 - Motor Switching Analysis
 - DC-DC Converter - Switching Frequency, Gate Drive
 - Simple Switcher Analysis
 - Monte Carlo Analysis - The Right Way to do it
- 9. Extended Topics & Examples**
 - Stress & Derating
 - Electrolytic and Ceramic Capacitor Modeling
 - Discrete LDO Design and Modeling
 - Top Power Supply WC Failures