PCB Design for Military, Aerospace, and Extreme Environments
SYLLABUS

INSTRUCTOR INFORMATION

Instructor: Kristopher Moyer

Email: kristophermoyer@electronics.org

Phone: 916-674-2090

Contact Procedure: Usually available between 6pm – 9pm Pacific Time USA. Leave message anytime.

PROGRAM DESCRIPTION

In the highly competitive electronics industry, the knowledge and skills of staff directly responsible for the design and layout of the Printed Circuit Board (PCB) and Printed Board Assembly (PBA) can have a direct impact on the success or failure of the product design and impact time to market. The PCB Design for Military, Aerospace, and Extreme Environments is designed to provide the skills necessary to create PCB/PBA designs that require advanced or complex packaging, have reduced available board area, require non-orthogonal placement and routing, require non-standard board outline geometry, require non-standard board mounting, require advanced board materials, and comply with all necessary IPC standards. Taught by a certified industry expert with 25+ years of experience in the field, the eight-week program utilizes interactive webinars, on-demand recorded class sessions, job-specific exercises, and team projects to facilitate mastery of the key concepts required by circuit board designers.

This course is intended for those individuals who have completed or possess the equivalent skills and experience of PCB Fundamentals parts 1 & 2 and who need further experience with design, manufacturing, packaging, and routing challenges involved with designs for military, aerospace, and outer space applications. These skills include:

- Schematic symbol creation in accordance with (IAW) IPC-2612-1
- Schematic Generation IAW IPC-2612
- Documentation and Dimensioning IAW IPC-2614, IPC-2615, & IPC-D-325
- Standard Rigid Printed Board Design IAW IPC-2221 & IPC-2222
- Printed Board manufacturing IAW IPC-6011 & IPC-6012
- Printed Board Assembly IAW IPC-J-STD-001
- Basics of Signal Integrity

LEARNING AND PERFORMANCE OBJECTIVES

This program is designed to provide circuit board designers with a balanced foundation of theoretical knowledge and practical skills in printed circuit board design. Upon completion, participants will be able to:

- Design boards for military, aerospace, and outer space applications.
- Understand the trade-offs in materials used in these applications.
- Define a board stackup that implements structures that will meet the needs of these harsh environments.
- Understand and mitigate signal integrity issues for these environments.
- Understand and define the effects of mechanical retention needs for these applications.
- Define and implement component packaging methodologies to mitigate the effects of vibration, shock, and temperature on components used in these applications.
- Understand and mitigate the effects of the extended temperature range for operation in these applications.
- Introduction to radiation effects on these applications.

COURSE STRUCTURE

- Instructor and participants meet online twice per week from the comfort of their own home.
- Participants can view recorded online sessions to review course content and class discussions.
- Participants apply key concepts to create a real-world design from concept to completion.
- All required materials are included in the course. Participants may utilize a PCB design authoring software program of their choice. If participants do not have access to PCB design authoring software, the Global Electronics Association will provide complimentary access to a select choice of programs.
- Course materials are accessible 24/7 on Electronics U.
- The course can be accessed on virtually any device with an Internet connection and a major web browser, including Chrome, Firefox, Safari, Edge, and Internet Explorer.

IPC STANDARDS COVERED (PROVIDED WITH COURSE)

- IPC-2152 STANDARD FOR DETERMINING CURRENT CARRYING CAPACITY IN PRINTED BOARD DESIGN
- IPC-2221 GENERIC STANDARD ON PRINTED BOARD DESIGN
- IPC-2222 SECTIONAL DESIGN STANDARD FOR RIGID ORGANIC PRINTED BOARDS

- IPC-2611 GENERIC REQUIREMENTS FOR ELECTRONIC PRODUCT DOCUMENTATION
- IPC-2612 SECTIONAL REQUIREMENTS FOR ELECTRONIC DIAGRAMMING DOCUMENTATION (SCHEMATIC AND LOGIC DESCRIPTIONS)
- IPC-2612-1 SECTIONAL REQUIREMENTS FOR ELECTRONIC DIAGRAMMING SYMBOL GENERATION METHODOLOGY
- IPC-2614 SECTIONAL REQUIREMENTS FOR BOARD FABRICATION DOCUMENTATION
- IPC-2615 PRINTED BOARD DIMENSIONS AND TOLERANCES
- IPC-4101 SPECIFICATION FOR BASE MATERIALS FOR RIGID AND MULTILAYER PRINTED BOARDS
- IPC-6011 GENERIC PERFORMANCE SPECIFICATION FOR PRINTED BOARDS
- IPC-6012 QUALIFICATION AND PERFORMANCE SPECIFICATION FOR RIGID PRINTED BOARDS
- IPC-7351 GENERIC REQUIREMENTS FOR SURFACE MOUNT DESIGN AND LAND PATTERN STANDARD
- IPC J-STD-001 REQUIREMENTS FOR SOLDERED ELECTRICAL AND ELECTRONIC ASSEMBLIES
- IPC J-STD-001XS SPACE AND MILITARY APPLICATIONS ELECTRONIC HARDWARE ADDENDUM TO IPC J-STD-001H REQUIREMENTS FOR SOLDERED ELECTRICAL AND ELECTRONIC ASSEMBLIES
- IPC-J-STD-004 REQUIREMENTS FOR SOLDERING FLUXES
- IPC-J-STD-005 REQUIREMENTS FOR SOLDERING PASTES
- IPC-J-STD-006 REQUIREMENTS FOR ELECTRONIC GRADE SOLDER ALLOYS AND FLUXED AND NON-FLUXED SOLID SOLDERS FOR ELECTRONIC SOLDERING APPLICATIONS
- IPC-SM-840 QUALIFICATION AND PERFORMANCE SPECIFICATION OF PERMANENT SOLDER MASK AND FLEXIBLE COVER MATERIALS
- IPC-CC-830 QUALIFICATION AND PERFORMANCE OF ELECTRICAL INSULATING COMPOUND FOR PRINTED WIRING ASSEMBLIES
- IPC-CM-770 COMPONENT MOUNTING GUIDELINES FOR PRINTED BOARDS
- IPC-D-325 DOCUMENTATION REQUIREMENTS FOR PRINTED BOARDS

SUPPLEMENTAL MATERIALS

- Printed Circuit Handbook – Clyde F. Coombs, McGraw-Hill
- Right the First Time – Lee W. Ritchey Speeding Edge
- Signal Integrity Issues and Printed Circuit Boards – Douglas Brooks, Prentice Hall

COURSE SCHEDULE

WEEK 1 – BASIC CIRCUIT DESIGN

Program overview outlining class schedule and options for accessing class material and assignments. The session will focus on the basics of military/aerospace design.

Key concepts include:

- Stackup management
- CTE stresses
- Packaging challenges
- Test coverage/test access
- Mass
- Thermal control
- Isolation/power domains
- Power management / switch over

RESINS AND FOILS ASSIGNMENT:

- Design stackup for a simple board.

WEEK 2 – ADVANCED CIRCUIT DESIGN

Advanced military/aerospace design.

Key concepts include:

- Altitude effects
    - Pichon's curve
- Redundancy
- Acceleration
- Lightning
- Charge concentration
    - Point charge
    - Sharp corners
- Radiation Effects
- IPC standards

INDIVIDUAL ASSIGNMENT:

- Design board for satellite application
- Define mounting features to mitigate stresses on PCB material
- Define stackup / stackup zones

WEEK 3 – MATERIALS

Materials used in military/aerospace designs, physical properties, types of structures, and trade-offs.

Key concepts include:

- What materials are used in these designs
- How to define
- Physical and mechanical properties
- Trade-offs in different material types
- Vibration and shock
- Moisture
- Salt/sand effects
- Conformal coatings
- Potting compounds
- Staking compounds
- IPC standards

INDIVIDUAL ASSIGNMENT:

- Define different stackups for signal integrity, Navy, FAA, satellite

WEEK 4 – MANUFACTURING PROCESS

Military / Aerospace manufacturing process. Effects on design.

Key concepts include:

- Understand the manufacturing process used in these designs
- Understand special fabrication allowances for space designs
- Understand assembly challenges and mitigation with these designs
- Extended qualifications
- Tailored test and certification
- Conformal coating
- Potting
- Class 3 / space addendum
- Staking

INDIVIDUAL ASSIGNMENT:

- Design board for a space application involving staking and potting

WEEK 5 – DOCUMENTATION

Produce proper documentation in compliance with IPC standards for these designs.

Key concepts include:

- IPC-2610 series.
- IPC-D-325.
- IPC-J-STD-001
    - Space addendum
- Documentation methodology
- Special feature call-outs

INDIVIDUAL ASSIGNMENT:

- Create documentation package
- Define all special requirements described in the course session

WEEK 6 – CONTENT REVIEW AND FINAL EXAM

The class session will focus on content review and the final exam. Session 1 will be a review, and Session 2 will be available for the final exam.

INDIVIDUAL ASSIGNMENT:

- none

FINAL EXAM:

- Access the final exam during the last week of the course.
- Completion of the program with a score of 70% or higher on the final exam is required to earn a certificate of completion.
- Attempts allowed: 2. Grading method: Highest grade.