
REVIEWED BY: ANTHONY J. RAFANELLI

This review has been performed from an industry user’s point of view. Dr. Michael Pecht has produced a very good work which provides a “soup to nuts” compendium of electronic package design. The book is comprised of twelve (12) chapters, each written by a noted authority in the specific topic area. The book appears to cover all the necessary aspects in the electronic packaging development process. Inclusion of an “acronyms” section is a clever addition to the book’s value.

Chapter 1 provides a very good introduction. It is nice to see a text that confirms that electronic packaging is a multi-disciplinary practice, i.e. “…must integrate the skills of electrical, mechanical, manufacturing, industrial, material, and systems engineers.” This reviewer might be so bold as to add the aerospace engineer (to add avionics expertise) and the chemical engineer (to add additional production process experience) to the electronic packaging design process. Some good explanations are also provided regarding levels of integration at chip (small-scale, medium scale, large scale, very large scale, and ultra large scale) and wafer levels. Also, good information is provided on electronic packaging levels including information on chip feature, chip cell sizes, chip size, and chip complexity. Additional trend data is provided on PWB features. The chapter ends with a discourse showing the interrelationships between all engineering disciplines in the design and manufacturing of electronic products. Included is a discussion of the significance of concurrent engineering and its effectiveness in electronic product development. Finally, a comprehensive list of publications (journals, magazines, etc.) is provided as a reference base. Surprisingly, the Transactions of the ASME Journal of Electronic Packaging, while mentioned in the text, was not included in the listing.

Chapter 2 discusses electronic components. A description of each type is provided. Component types include resistors, capacitors, inductors, diodes, transistors, and integrated circuits (ICs). The IC manufacturing process is presented as are packaging styles. Some very good graphics are used to describe these package designs.

Chapter 3 deals with printed wiring board design and fabrication. The chapter is well organized and provides a very good methodology in presenting the design and manufacturing processes. A discussion on organic printed wiring boards (PWBs) includes: 1. Artwork preparation, 2. Material preparation, 3. Plating-electroless copper, 4. Imaging, 5. Electroplating, 6. Resist removal, 7. Etching (which has good graphics in this process), 8. Electrical connections, 9. Reflow, 10. Sealing of board surface, 11. Panel/board separation, and 12. Inspection. The chapter continues with multi-layer board fabrication. There is a handy calculation on registration errors. This calculation is used to determine minimum achievable hole diameter for a given manufacturing process. Also discussed are soldering methods, ceramic PWBs, and screens versus stencils (including advantages and disadvantages of each).

Chapter 4 addresses electronic assemblies which are presented in four groups: 1. Elementary subassemblies, 2. Chip carrier assemblies, 3. Hybrid assemblies, and 4. PWB assemblies. Elementary subassemblies include die, capacitor bank, and microwave and RF. Chip carrier subassemblies include plastic, ceramic, and PGA. Surface mounted assembly is included in the PWB subassembly section. The chapter also includes a section on electrostatic discharge (ESD). Although a summary of this topic is provided, it would have been effective if some mention of various industry associations were provided in order that references could be obtained.

Chapter 5 talks about interconnections and connectors. The writer does a very good job of classifying interconnections as follows: 1st level chip and lead frame, 2nd level component leads to PWB, 3rd level PWBs to each other (i.e. edge connectors or backplanes), 4th level backpanels housed in drawers or gates to connect subassemblies, 5th level wiring of gates/drawers to I/O connections on cabinets and 6th level connections between cabinets and stations. Connector technology is also well addressed and includes information on low insertion force (LIF), zero insertion force (ZIF), and wiping forces.

Chapter 6 focuses on layout. Discussions include partitioning and placement. Placement of routability includes discussion on distance functions such as Manhattan (rectilinear) distance and Euclidean distances. Other topics include iterative placement techniques. Some of the approaches included are Steinberg’s algorithm, pair-wise interchange, and forced-directed methods. Interestingly, these authors make a case to include reliability as part of the initial placement process rather than as a post process. Their focus is on thermal management in which convection and conduction methods are discussed. Also mentioned is placement for productivity. The chapter ends with discussion on routing.

Chapter 7 discusses thermal design and analysis. It leads off with a very nice talk on the aims of thermal analysis and control. The graphics and models are effectively presented. All three heat transfer modes (conduction, convection, and radiation) are adequately covered. Included in the discussions are fins, contact resistance, and electronic miniaturization effects. One comment is that the chapter references include all of the major electronic thermal management experts. However, a suggestion, for future editions, is to consider referencing and incorporating some of Tony Kordeban’s concepts and approaches to thermal management. As a handbook, this work would do well to include some more recent thermal management summary styles.

Chapter 8 addresses thermo-mechanical analysis and design. It does a good job in presenting concepts of thermo-mechanical analysis and design, which are identified as thermo-elasticity and fatigue. Regarding thermo-elasticity, this reviewer considers this subject a specialized version of elasticity as affected by temperature.
ture. Thus, it is an illustrative as well as critical example of a multi-disciplinary approach to electronic packaging development. Regarding fatigue, explanations are provided to distinguish high cycle ($> 10^4$ cycles) and low cycle ($< 10^4$ cycles). Another suggestion would be to provide some further definition or explanation on the transition region which many, in the industry, claim exists. The chapter also contains good presentations on thermal cycling, thermal shock, and power cycling. Some data is presented (for tutorial purposes) on fatigue life as affected by chip carrier size and solder joint heights with relationships to PWB materials.

The topic of Chapter 9 is designing for vibration and shock. Contents include tutorials on basic vibration concepts and include a discussion on fatigue and combined vibration and thermal loading.

Chapter 10 focuses on analysis and design for humidity and corrosion concerns. The chapter is unique in that it presents tutorials on humidity and its effect on electronics integrity (not usually seen in most handbooks). Included is a list of typical problems attributed to humidity. Hermeticity is discussed. Some applicable information is provided regarding acceptable limits for various packages. The impact of humidity on plastic encapsulated microcircuits (PEMS) is also included. The chapter also presents talk on corrosion (uniform, galvanic, and pitting) as well as those factors that affect corrosion rates. Some corrosion models are presented such as Arrhenius-Eyring (from the Motorola™ Discrete and Special Technologies Group) and the IIT/Honeywell™. The chapter ends with development of corrosion models and corrosion testing approaches.

Chapter 11 focuses on designing for reliability. It begins with an interesting introduction of a technology curve, which appears to be an inverted “bathtub” curve. It plots usage versus time and tracks the traditional reliability curve. A very adequate tutorial on reliability is also provided. Of further interest is a section that discusses preferred parts selection and qualification. Finally, other interesting topics include derating, accelerated life testing (under temperature, humidity and combinations thereof), screening, reliability models, FMECA (failure modes), and reliability growth.

Chapter 12 discusses electronic materials and their properties. A large quantity of data is provided on PWB, enclosure, adhesive/bonding, encapsulant, and coating materials. Corrosion of these materials is also discussed.

In summary, *Handbook of Electronic Package Design* provides a very comprehensive collection of all vital elements in electronic packaging development. Important concepts such as reliability, manufacturability, and materials science are included. The chapter authors represent a group of very respected and experienced people in the industry. The book is a very good all-purpose tool and it is highly recommended for practicing engineers in the electronics industry.