



Essentials of Electronic Packaging

A Multidisciplinary Approach

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ASME Press Book Series on Electronic Packaging

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Table 1.2 Hierarchical Levels of Electronic Packaging

Packaging hierarchy levels	Description
Level 0	Packaging different functions on to a semiconductor chip. A device or chip with multitudes of transistors, circuits, gate-to-gate interconnections, etc., several functions incorporated into the semiconductor processor chips, memory chips, logic chips, chip level interconnects, etc.
Level 1	The process of assembling a chip or chips into an enclosure that constitutes an SCM or MCM. These can be leaded, pin grid array, leadless, or area array, packages either hermetic or nonhermetic ceramic or plastic encapsulated, or tape automated bonding packages
Level 2	Assembling the leaded or leadless first-level packages, capacitors, resistors, memory, logic, power supplies, etc., on to a back plane or motherboard. Also, assembling a number of smaller cards with specific functionalities on a panel
Level 3	Packaging the motherboard back planes, daughter boards, baby boards
Level 4	Box-level packaging with connecting cables, storage device, cabling, rack or box mounting, etc.
Level 5	Connecting host to terminals, printers, other peripherals, etc.

as third-level packaging. However, level 3 packaging classification is sometimes expanded into more levels of packaging. In such a scheme, level 3 packaging consists of only assembling the various PWBs which involves packaging motherboards, daughter boards, baby boards, etc. Level 4 packaging involves connecting the subassemblies together. This also called box-level packaging. An example is putting together a rack or shelf containing several subassemblies. Level 5 packaging can consist of interconnecting the computer to such peripherals as printers, connecting the host computer to terminals, etc. Table 1.2 shows the various levels of packaging and a brief description of each.

It is important to recognize that these classifications are more for convenience in dealing with the different parts of the system. While the first- and second-level packaging nomenclature are well adapted, the terminology for the others varies among users. Electronic packaging is generally driven by topological, electrical, thermal, reliability, and manufacturability considerations.

PACKAGING NOMENCLATURE

Packages are sometimes called chip carriers as these enclosures contain the functional semiconductors and are categorized in a number of ways. From the materials perspective, they are classified as ceramic and plastic packages. Plastic packages are also referred to as plastic encapsulated microcircuits (PEMs). On one hand, ceramic substrates generally lend themselves to fine-line wiring, these are used where high I/O and hermeticity are required and package weight is not an impediment. These are better-suited for high-temperature applications

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Table 1.3 Relative Advantages and Disadvantages of Ceramic and Plastic Packaging

Package type	Advantages	Disadvantages
1 Ceramic	Hermetic High I/O capability High-temperature application Multichip capability	Heavy Brittle Low CTE and not preferred for organic carrier assembly Low-volume manufacturing Expensive
2 Plastic	Lighter Cheaper High-volume manufacturing Multichip capability Package stacking capability	Lighter Moisture sensitive Lower I/O capability Higher CTE and not preferred for ceramic laminates Not for high temperature applications Low performance

such as military and automotive under-the-hood applications that use ceramics which are refractory materials. On the other hand, PEMs are used where hermeticity is not mandatory, and package weight and cost are the most desirable attributes. Table 1.3 shows a comparison of relative advantages and disadvantages of ceramic and plastic packages.

The second nomenclature depends on the board assembly technology. In the early days of electronic packaging development, packages were assembled on the PWB by inserting the package leads into corresponding holes in the printed wiring board, and these were termed through-hole packages or insertion mount packages. However, electronics assembly technology underwent a paradigm shift owing to the need for higher and higher packaging density, thus migrating from insertion mount to surface mount assembly. In surface mount technology (SMT), the packages are literally mounted or seated on the surface of the board, and hence these are called surface mount components (SMCs). SMCs occur in three variations, namely, leadless, leaded, and area array packages, described in more detail in a later chapter. Figure 1.2 shows general semiconductor packaging schemes in vogue.

The terms packages, assemblies, and product are sometimes used interchangeably in the industry. When computer companies are vertically integrated in structure, all the different constituents of the system are designed, assembled, and manufactured in the same company. However, over time, constraints such as cost-competitive pressures, short product development cycles, etc., have resulted in an industrial environment where the different components and constituents are designed, manufactured, and supplied to a system manufacturer. Thus, in an information processing system such as a laptop, the memory, processor, logic, disk drives, motherboard, daughter cards, etc., can be from different suppliers. For the supplier each of these components individually is a product. Each of these is tested to specific functional requirements, quality standards, and reliability. Thus, it is important to recognize that a first-level package is by itself a completed product. Similarly a motherboard with different constituent parts, active and passive packages, connectors, etc., is a product. However, at a system level,

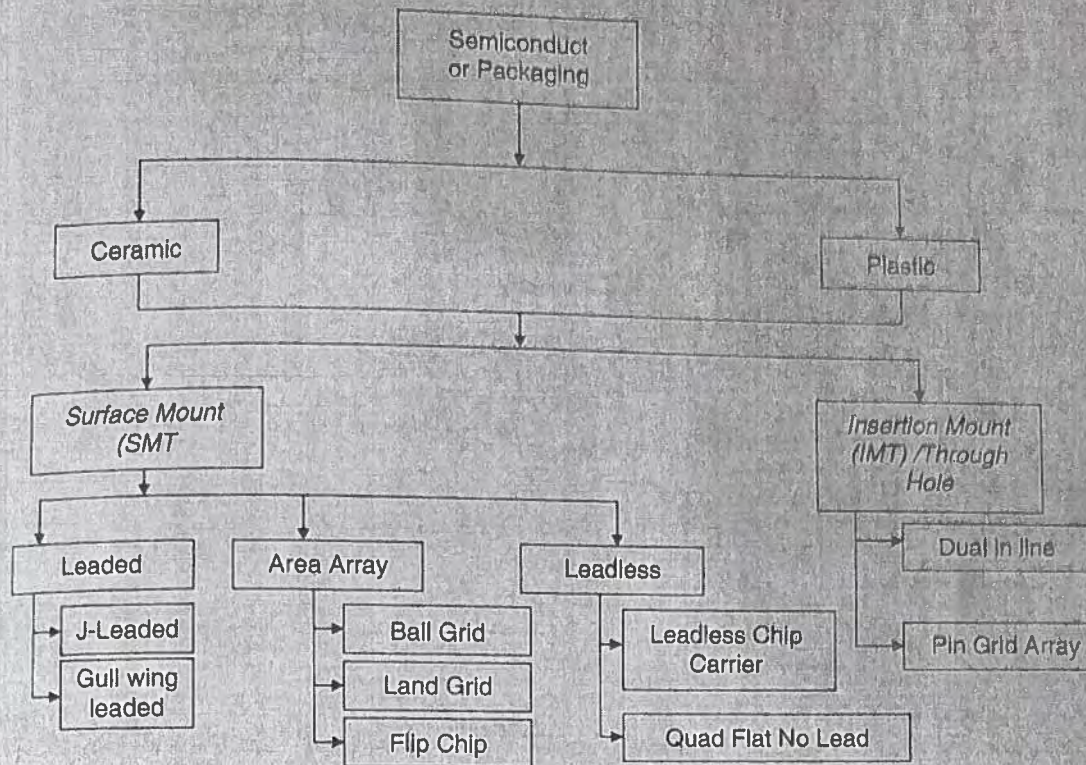


FIGURE 1.2 Packaging schemes in semiconductor packaging.

the individual assemblies are categorized as first level, second level, third level, and so on. While a given system may be tested and qualified for a given usage and product environment, individual packages and subassemblies may be tested in a much stringent and harsher environment since the package supplier may not be aware of the final system usage and life requirements. Thus, it is important to be cognizant of the distinction between the component requirements and the system requirements as well as the circumstances in which a package or a circuit card assembly (CCA) are by themselves products. Figure 1.3 depicts examples of different levels of packaging as well as the overlapping package-product designation similarities and distinctions.

PRODUCT CATEGORIES

There is a wide range of product categories among computers. High-end computers are those that have enormous computing capabilities with the least amount of downtime. These are generally used in banking systems, mission critical systems, airline reservation, traffic control systems, military and space electronics, and the like. The second category comprises midrange computers that are catered to the needs of businesses. The third category is the low-end systems and these comprise of personal computers and the like. Products are also categorized on the basis of operating conditions and life requirements. Some are required to operate without failures for as long as 20 years, whereas others like consumer