Chapter 6
Surface Mount Land Pattern Design

6.0 INTRODUCTION

Surface mount land patterns, also referred to as footprints or pads, define the sites at which components are to be soldered to a printed circuit board. The design of land patterns is critical because it not only determines solder joint strength, hence reliability, but it also influences the areas of solder defects, cleanability, testability, and repair/ rework. In other words, the very producibility of surface mount assemblies depends on land pattern design. However, the producibility of a surface mount assembly (SMA) is not determined by pad design alone. Materials, processes, components, and board solderability also play very important roles. These issues are covered elsewhere in this book.

Poor component tolerances and the lack of standardization of surface mount packages have compounded the problem of standardizing the land pattern design. Numerous package types are being offered by the industry, and the variations in a given package type can be numerous, as well. More important, the tolerance on components varies significantly, causing real problems for land pattern design and adding to the manufacturing problems for SMT users.

Consider the component tolerance found in “standard” 1206 resistors and capacitors. These items are anything but standard: the tolerance of the most important dimensions—the termination width—varies from a minimum of 10 mils to a maximum of 30 mils (nominal dimension is 20 mil). With a tolerance variation of this magnitude, the design of land patterns is challenging indeed.

The technical societies, such as the Institute of Interconnecting and Packaging Electronic Circuits (IPC), the EIA, and the Surface Mount Council, are doing everything they can to improve the current situation as far as component standardization and tolerances are concerned. For example, the IPC chartered the Surface Mount Land Pattern Committee
(IPC-SM-782) to standardize the land patterns for surface mount components [1].

Through the efforts of the Surface Mount Council, there is now a significant amount of coordination between the EIA and the IPC to ensure compatibility between component outlines (established by the EIA) and their land patterns (established by the IPC). As chairman of IPC-SM-782, I had the privilege of working with many individuals from EIA and IPC member companies to develop land pattern designs for surface mount components. For example, any new component outline considered by the EIA parts committee is first reviewed by the IPC land pattern committee before a final decision is made [2]. The IPC-SM-782 land pattern guidelines offer a good example of the industry’s effort to promote standardization in surface mount technology.

IPC-SM-782 is a good source for the latest information on land pattern design. It is revised on a regular basis to reflect the changes in component availability. It should be noted, however, that IPC-SM-782 is primarily a land pattern document and not a design for manufacturability (DFM) document. We should also keep in mind that neither this book nor any other book is a substitute for an in-house DFM document, although they may be good places to start. Why? An in-house DFM document is critical for fully optimizing one’s design for one’s specific manufacturing processes and equipment. A DFM document should encompass issues discussed in Chapters 3, 4, 5, 6, and 7 of this book and should provide a specific number for land pattern design, via size, interpackage spacing, and a host of other variables as discussed in Chapters 5, 6, and 7.

In this chapter we discuss the basic concepts of land pattern design for different package types, including the formulas that serve as the basis for the land patterns. This information can also be used for developing land patterns for newer components as they become available or when the dimensions of the existing components change.

The formulas were developed after extensive testing for reliability and manufacturability of assemblies soldered by reflow and wave soldering (reflow soldering of active components and reflow and wave soldering of passive components). The test boards were tested for reliability by thermal and mechanical cycling for solder joint failures. Some of the results of the test program have been published [3].

To simplify the land pattern design guidelines discussed in this chapter, let us divide surface mount components into categories. For each category, we first discuss the basic concept and then the formulas for land pattern design. Finally, the specific land pattern dimensions are given.