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Review

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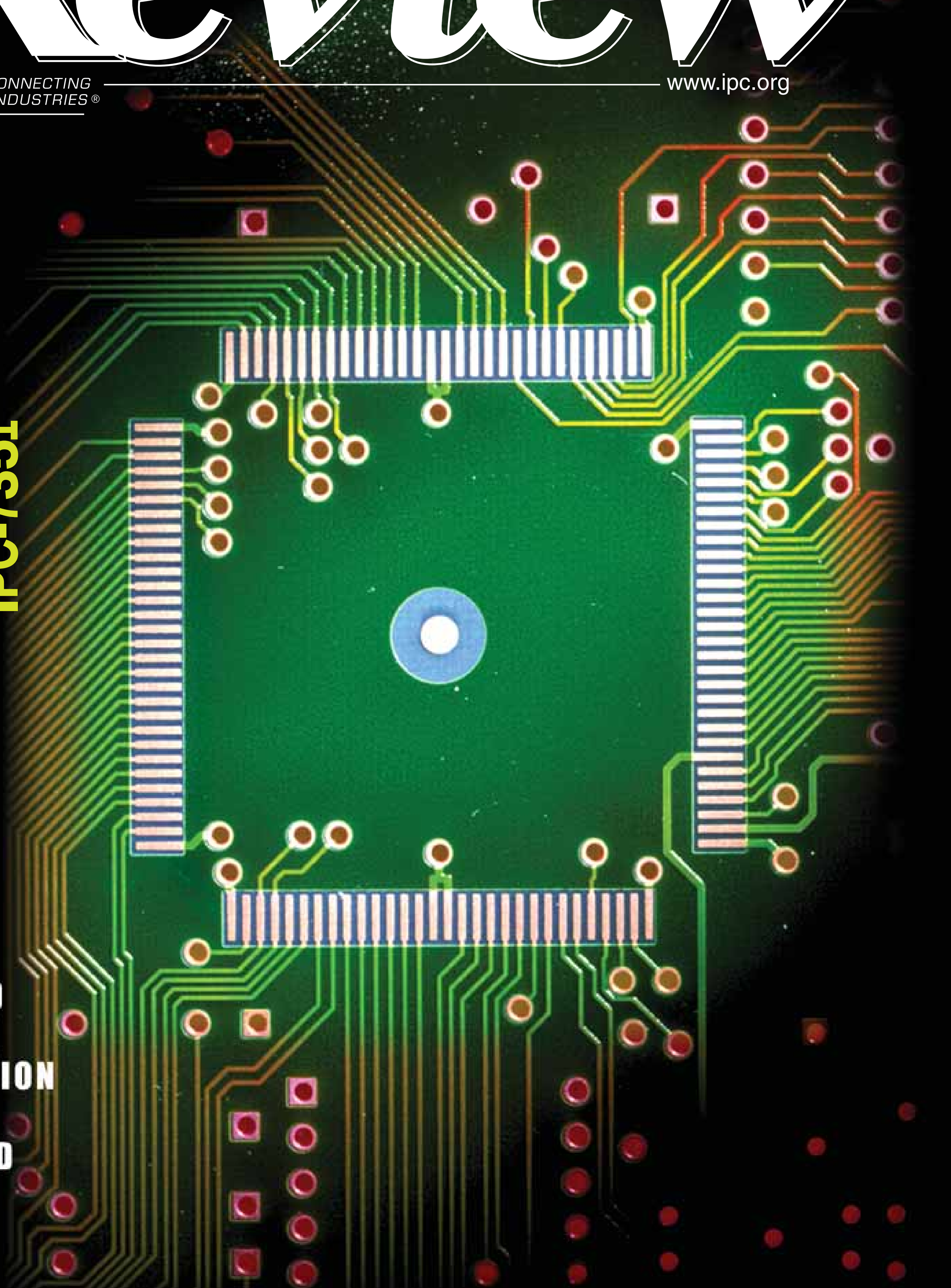

IPC-7351

IPC LAND PATTERN GENERATION LEAPS FORWARD

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FROM THE PAST ...

Since 1987, whenever the industry has needed information on land pattern dimensions and tolerances, it has relied on IPC-SM-782, *Surface Mount Design and Land Pattern Standard.* Undergoing a complete overhaul in 1993 to Revision A, and followed up by amendments in 1996 for new chip components and again in 1999 for BGA components down to 1.0 mm pitch, the document has provided users with the appropriate size, shape and tolerance of surface mount land patterns to ensure adequate solder fillets while allowing for the inspection and testing of those solder joints. Still, the document had struggled to keep up with the increasing proliferation of new component families and the onward push toward tighter component densities. IPC recognized that a paradigm shift was in order.

RIGHT INTO THE FUTURE....

This month, IPC anticipates the release of the long-awaited successor to IPC-SM-782A, IPC-7351, *Generic Requirements for Surface Mount Design and Land Pattern Standard.* Much more than an updated land pattern standard addressing new component families such as Quad Flat No-Lead (QFN) and Small Outline No-Lead (SON), IPC-7351 represents a change in the way land patterns are developed, categorized and defined, all key ingredients to building a new industry CAD library.

HOW SMALL DO YOU WANT IT?

The primary concept of IPC-7351 revolves around three new application-specific land pattern geometry variations that are designed to support various levels of product complexity. Whereas IPC-SM-782 provided a single land pattern recommendation for a given component, IPC-7351 acknowledges that variables such as component board density, high shock environments and the need for rework and repair all contribute to the need for more than just one land pattern recommendation. As such, IPC-7351 provides the following three land pattern geometry concepts for each component that the user may select from:

Density Level A: Maximum (Most) Land Protrusion — for high component density applications typical of portable/hand-held products and products exposed to high shock or vibration. The solder pattern is the most robust and can be easily reworked if necessary.

Density Level B: Median (Nominal) Land Protrusion — for products with a moderate level of component density and providing a robust solder attachment

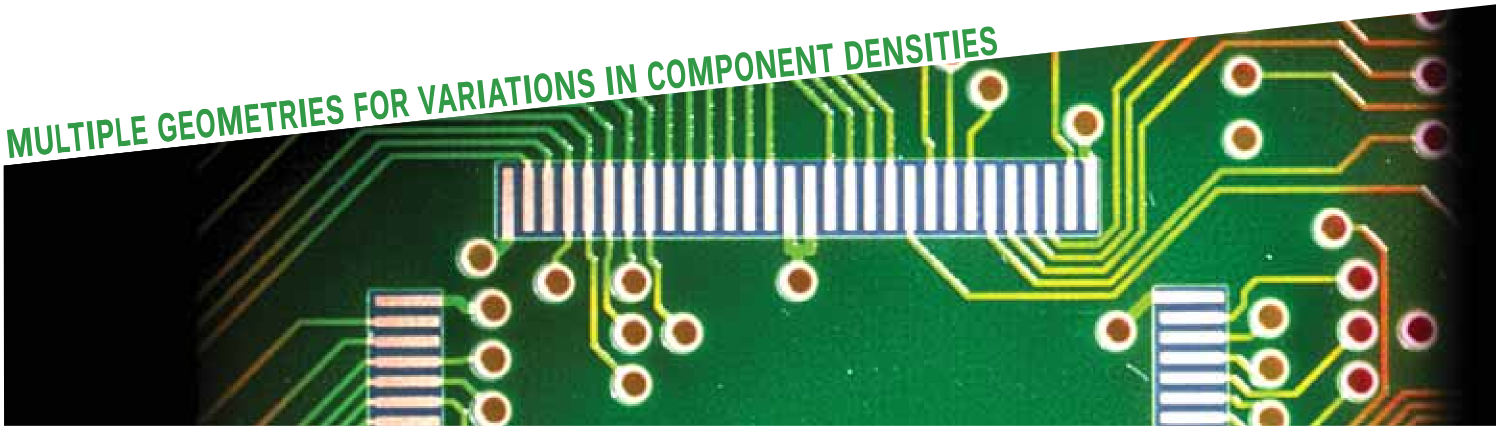
Density Level C: Minimum (Least) Land Protrusion — for miniature devices where the land pattern has the least amount of solder pattern to achieve the highest component packing density

As Figure 1 shows, the goals for the solder fillets at the toe, heel and side of each solder joint, as well as the goals for the placement courtyard excess, all contribute to the differences among the three land pattern geometries.

INTELLIGENT LAND PATTERN NAMING CONVENTION

IPC-SM-782 provided a registered land pattern (RLP) for each component addressed in the standard. Basically a three digit number, where a range of RLP numbers were assigned to a given component family, the convention did

MULTIPLE GEOMETRIES FOR VARIATIONS IN COMPONENT DENSITIES



not provide any intelligence that would convey to engineers or manufacturers information on the parts themselves; in fact, the proliferation of components within a given family such as Thin Small Outline Package (TSOP) practically guaranteed that at some point the range of RLP numbers assigned to that family would be exhausted.

In place of the RLP convention, IPC-7351 provides an intelligent land pattern naming convention that not only aids in the standardization of electronic schematic symbols for engineering, but also communicates component information between engineering, design and manufacturing. For example, the generic naming convention for a 0.80 mm pitch Quad Flat Package (QFP) would be:

QFP80P+Lead Span L1 Nominal X Lead Span L2 Nominal – Pin Qty

where the + (plus sign) stands for "in addition to" (no space between the prefix and the body size),

the X (capital letter X) is used instead of the word "by" to separate two numbers such as height X width,

the – (dash) is used to separate the pin quantity,

and the suffix letters "L", "M" and "N" signify when the land protrusion is at its minimum (least), maximum (most) or median (nominal) geometry variation.

Therefore, the land pattern name QFP80P+1720 X 2320-80N conveys the following information:

The component family prefix of QFP

The component pin pitch of 0.80 mm

The component lead span nominal X = 17.20 mm for "1720"

The component lead span nominal Y = 23.20 mm for "2320"

The total component pin quantity of 80 pins

The median (nominal) land pattern geometry

By providing intelligent information in the land pattern naming convention, IPC-7351 allows for enhanced search capability of land patterns within CAD libraries, allowing the user to search on multiple attributes to look up a specific part.

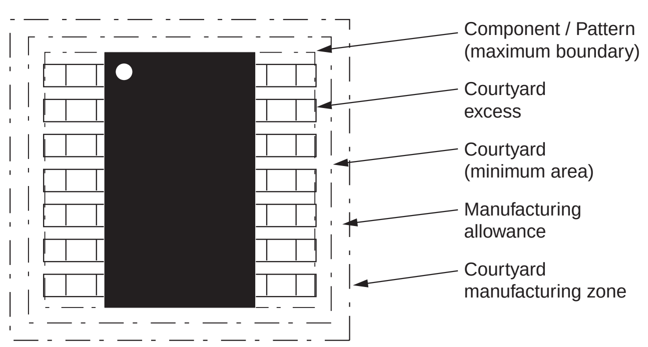
PLACEMENT COURTYARD

IPC-7351 provides expanded coverage for the land pattern courtyard, which accounts for the minimum electrical and mechanical clearance of both the component boundary extremities and the land pattern boundary extremities. This coverage aids the board

Figure 1 – Goals for Capacitors and Resistors Equal to or Larger than 1608 (0603)

Lead Part	Minimum (Least) Density Level C	Median (Nominal) Density Level B	Maximum (Most) Density Level A
Toe (J_T)	0.15	0.35	0.55
Round-off factor	Round off to the nearest two place even decimal, i.e., 1.00, 1.20, 1.40		
Heel (J_H)	-0.05	-0.05	-0.05
Round-off factor	Round off to the nearest two place even decimal, i.e., 1.00, 1.20, 1.40		
Side (J_S)	-0.05	0.00	0.05
Round-off factor	Round off to the nearest one place decimal, i.e., 1.0, 1.1, 1.2, 1.3		
Courtyard excess	0.1	0.25	0.5

Figure 2 – Courtyard Boundary Area Conditions



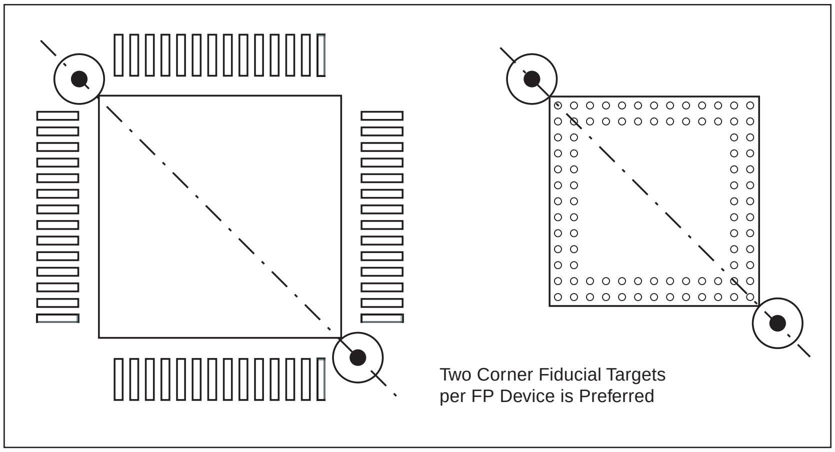


Figure 3 – Local Fiducials

designer in determining the minimum area occupied by the combination of component and land pattern. Figure 2 (preceding page) depicts the factors taken into consideration for a land pattern placement courtyard.

DESIGN GUIDANCE AND ASSEMBLY CONSIDERATIONS

IPC-7351 provides new design guidance for fiducial marks (Figure 3) as well as vias under components and within lands. The standard also addresses assembly considerations by covering laser cut stencil developments and solder preforms, as well as covering solder processes such as laser and conduction reflow soldering.

ZERO COMPONENT ROTATIONS

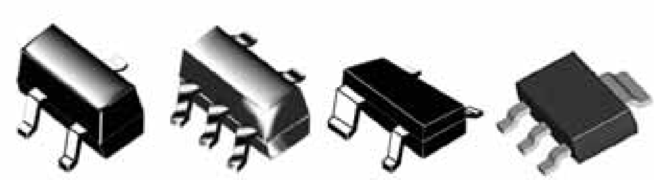
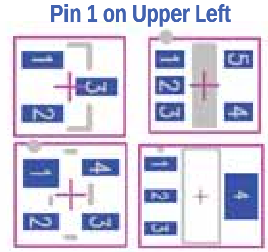
A new feature of IPC-7351 are zero component rotations which are designed to allow CAD land patterns to be built with the same rotation for the purpose of assembly machine automation. The rotations expressed in IPC-7351 will be defined in terms of the standard CAD component library with respect to a given PCB design. This is accomplished with the recognition that a single land pattern may be used for the same component part from different component suppliers and that each component supplier may have different orientations on their reels or that the components may come in trays. Thus, the IPC-7351 zero component rotation scheme helps prevent those scenarios where a PCB designer loses the ability to reference a single land pattern when the zero rotation of a part is according to the method the component is delivered to the assembly machine. Figure 4 shows an example of an IPC-7351 zero component rotation for Small Outline Transistor (SOT) packages.

IPC-7351 LAND PATTERN VIEWER

The Land Pattern Viewer is a key component of IPC-7351. It is a shareware program included with the standard on CD-ROM that allows users to view component and land pattern dimensional data for standardized component families in tabular form as well as through graphical images that illustrate how a component is attached to the land pattern on the board. This shareware viewer boasts a number of improvements over the previous online IPC-SM-782 calculator. For example, the IPC-SM-782 calculator contained only static component and land pattern images for a given component family. The IPC-7351 Land Pattern Viewer provides a specific component and land pattern graphic for each land pattern geometry and is built using the dimensions and tolerance for that part. The Land Pattern Viewer also provides enhanced search capabilities among multiple component libraries, aided by the IPC-7351 land pattern naming convention. Users can look up components and land patterns by searching on such attributes as pin pitch, pin quantity, part name or lead span, to name a few. Figure 5 provides an example of how the IPC-7351 Land Pattern Viewer displays component as well as land pattern dimensional data for a given component.

The IPC-7351 Land Pattern Viewer relies on library files, know as .p files, for component and land pattern dimensional data. As new component families are standardized by the industry and approved by IPC, new .p library files will be made available to users of the IPC-7351 Land Pattern Viewer for free download. This shareware program is also supported by additional

Figure 4 - Zero Component Rotations for Small Outline Transistor (SOT) Packages

PACKAGE OUTLINE	COMPONENT EXAMPLES	ZERO ROTATION
SOT COMPONENTS	 SOT23-3 SOT23-5 SOT343 SOT223	Pin 1 on Upper Left  Land Pattern

software programs that allow for the calculation of new land patterns as well as the creation of new parts libraries that store new component and land pattern data. Updated .p library files, new versions of the IPC-7351 Land Pattern Viewer, and information on supplemental calculators and library generators are all available at www.ipc.org under the “PCB Tools and Calculators” link.

SCHEDULED RELEASE

Following the completion of its balloting period, IPC-7351 is expected to be released in January 2005. Like its predecessor, IPC-7351 relies on proven mathematical algorithms that take into account fabrication, assembly and component tolerances in order to calculate precise land patterns. The standard improves upon the concepts developed for IPC-SM-782 by establishing three land pattern geometries for each component, providing clear descriptions of the solder joint engineering goals for each component family, as well as providing the user with an intelligent naming convention that aids in the lookup of land patterns. For more information on IPC-7351, contact John Perry, IPC’s technical project manager, at johnperry@ipc.org or 847-597-2818.

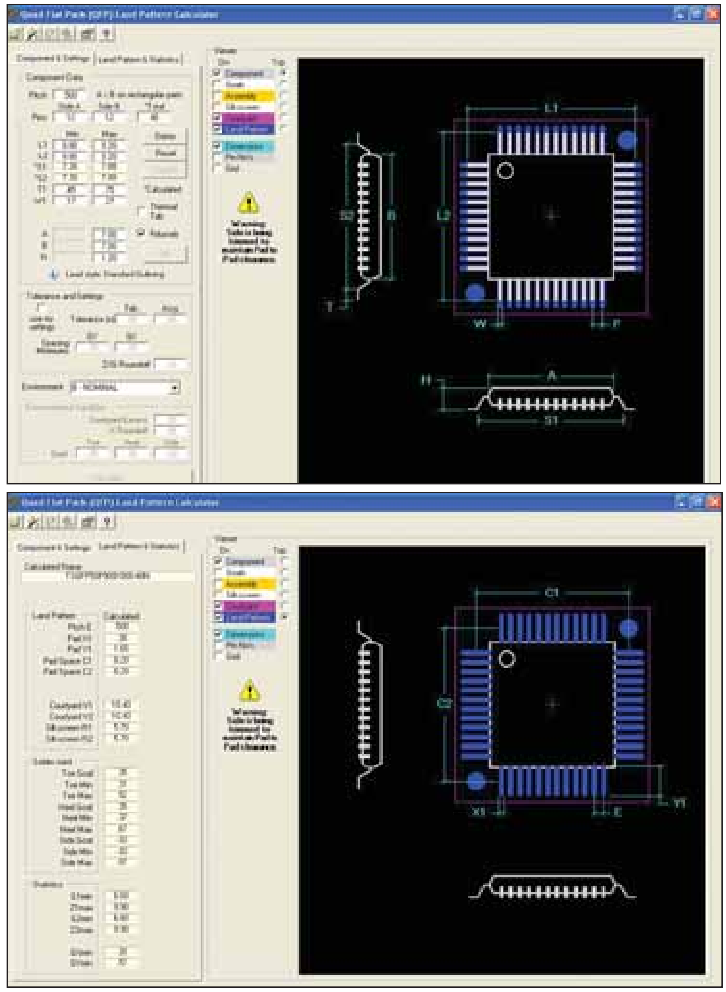


Figure 5 – IPC-7351 Land Pattern Viewer screenshot for QFP component and land pattern dimensions