

SOLDERBALL PIN™ TECHNOLOGY PROVIDES SMT REFLOW SOLUTION TO CO-PLANARITY INTERCONNECTION ISSUES FOR PCB-BASED SUBASSEMBLIES AND POWER MODULES

by

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Abstract:

Autosplice will detail the theory and qualification of a new interconnect with integrated Solderball Pin™¹ technology that enables efficient automated manufacture of surface mount PCB subassemblies, such as board-mounted point of load power modules. Power modules manufactured as a printed circuit board (PCB) subassembly are parallel stacked to a customer's host PCB. These modules are representative of many other motherboard/daughterboard assemblies that require interconnects with a high degree of mechanical and electrical integrity. Managing coplanarity variances between the PCB modules and motherboards during the final assembly process is critical to ensure that all contact points form robust solderjoint connections.

Solderball Pin™ technology employs a highly conductive copper pin that incorporates an integrated solder ball that interfaces to the host PCB. Solderball™ pins add two important attributes to parallel stacked assemblies by providing additional solder and allowing the sub-assembly to drop slightly when the solder becomes liquid. This drop occurs when the weight of the upper mezzanine PCB module overcomes the buoyancy of the molten solder, made possible by the enhanced pin to solder ball design. These two attributes allow Solderball™ Pin technology to automatically compensate for PCB coplanarity [1] variances up to .015" during solder reflow.

The inherent design of solderball pins allows designers of PCB-based modules complete flexibility to determine the optimal pattern and positioning of individual interconnects. Therefore, engineers are able to maintain design and layout consistency between new SMT versions and through-hole versions, ensuring a smooth roadmap of evolutionary product offerings and surface mountable product options.

Power modules or other PCB-based daughter-board assemblies that are manufactured using solderball pin™ interconnects can be delivered to OEMs or contract manufacturers as surface mount components that are ready for assembly into the customers' final products using standard automated placement and SMT reflow soldering methodologies.

¹ Solderball Pin™ is a trademark of Autosplice, Inc.

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Background:

Solderball pin™ Technology became the preferred standard in the Point of Load power industry due to the product characteristics and inherent capabilities that resolved three major application requirements: Limited PCB Real-Estate, High Power SMT compatibility and Coplanarity compensation.

Limited PCB Real-Estate

PC Board stacking design practices called mezzanine or parallel boards, provide significant advantages for segmenting specific application functions, while efficiently utilizing limited space in products such as power modules, wireless handsets, mobile hand-held devices, Ethernet and Fibre Channel sub-assemblies that combine Motherboard to Daughter-board configurations. The amount of real state required can be reduced in half in a double-sided daughter board power application, (See Figure 1).

An inherent advantage of board stacking is that some of the major components generating large amounts of “Heat” can be located on top of the daughter PCB for natural convection thermal dissipation. The heat source can be isolated from the Host PCB, eliminating the need for extra thick copper vias or heat sink requirements.

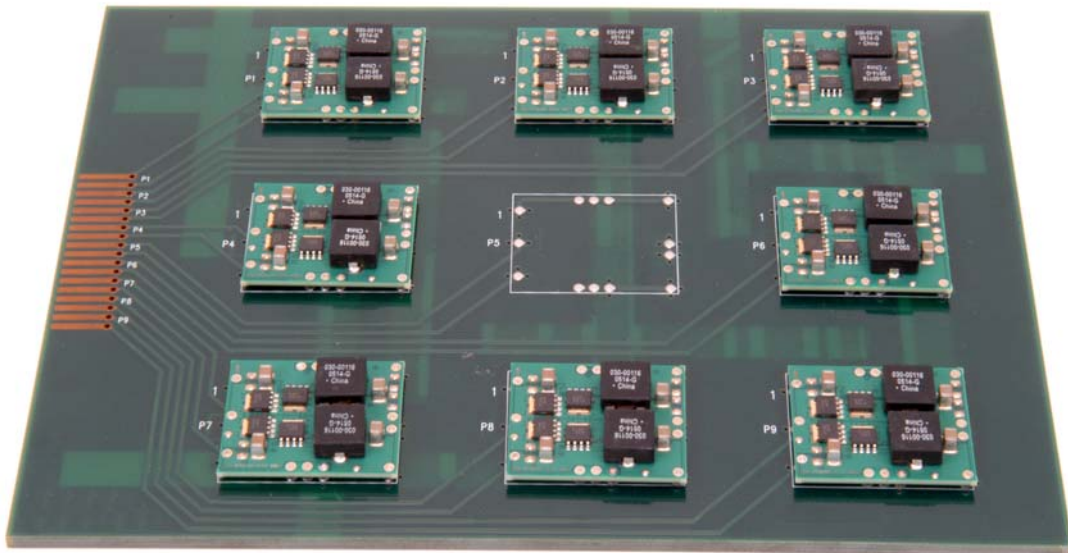


Figure 1

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High Power SMT Compatibility

Through Hole Technology (THT) and wave soldering are rapidly becoming obsolete, as the THT designs transition to SMT products that have overcome the most common issues like plated hole solder non-fill. The use of Solderball pin™ technology addresses this issue by providing an efficient method for automated placement of interconnects between both secondary and primary PC boards while effectively resolving any gap anomaly created between the PCB interconnection during SMT reflow. This gap normally called co-planarity variance is filled by the combination of the mass of molten solder created from the solderball pin™ solder sphere and the solder paste previously printed onto the SMT pad, (See Figure 2).

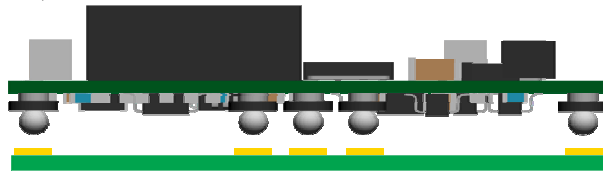


Figure 2

The result is that this technology is a drop in replacement for PCB designers and power module manufacturers, where the SMT land pattern footprint follows the previous generation THT allowing the formation of a repeatable fillet eliminating “hole fill” concerns. Since solderball pin™ products are discrete components, the design flexibility is infinite for any configuration on current technology as well as next generation PCB’s with modular mezzanine designs.

Solderball Pins electrical conductivity capabilities range from 5-50 amps in order to accommodate the varied requirements of today’s power device applications by utilizing different pin configurations and arrays that conform to the two most prevalent PCB hole diameters currently used in the power industry, 0.040” (1mm) and 0.062” (1.5mm). Thanks to this component characteristic, design and process engineers have optimal flexibility for using the same core production processes to create either conventional modules with through hole pins or SMT modules using Solderball Pins. (See Figure 3).

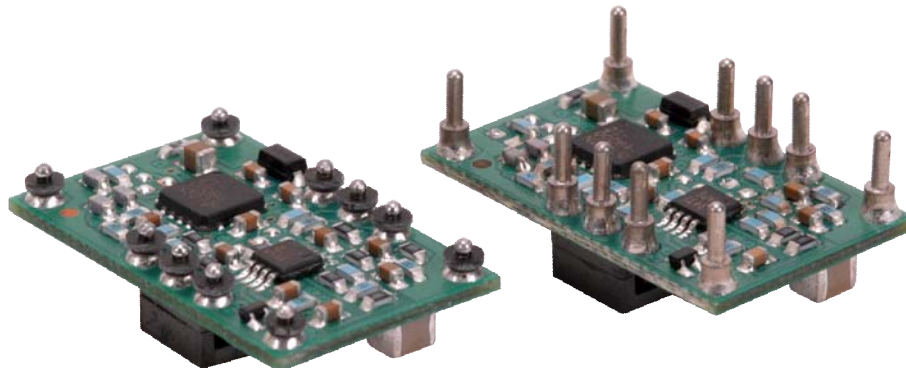


Figure 3

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Coplanarity Compensation

Solderball Pin™ technology incorporates several unique design features. During the manufacturing process, one end of the Solderball Pin™ component is placed directly (pin thru paste) onto the daughter-board assembly via plated through hole with standard reflow process. The other end of the product contains a solderball sphere that offers a ready-to-use SMT-compatible interface for assembly to the motherboard or Host PCB. This combination of product features creates a tremendous process advantage in multiple reflow applications by eliminating co-planarity mismatch [2].

During reflow, each solderball pin provides board-to-board adjustment flexibility that is equal to the distance by which the diameter of the solderball extends beyond the end of the pin inside the ball. The internal pin provides a rigid and high conductivity foundation and the reflow of the solderball allows a physical adjustment up to .015" (.381mm) as each solder joint is formed. (See Figure 4).

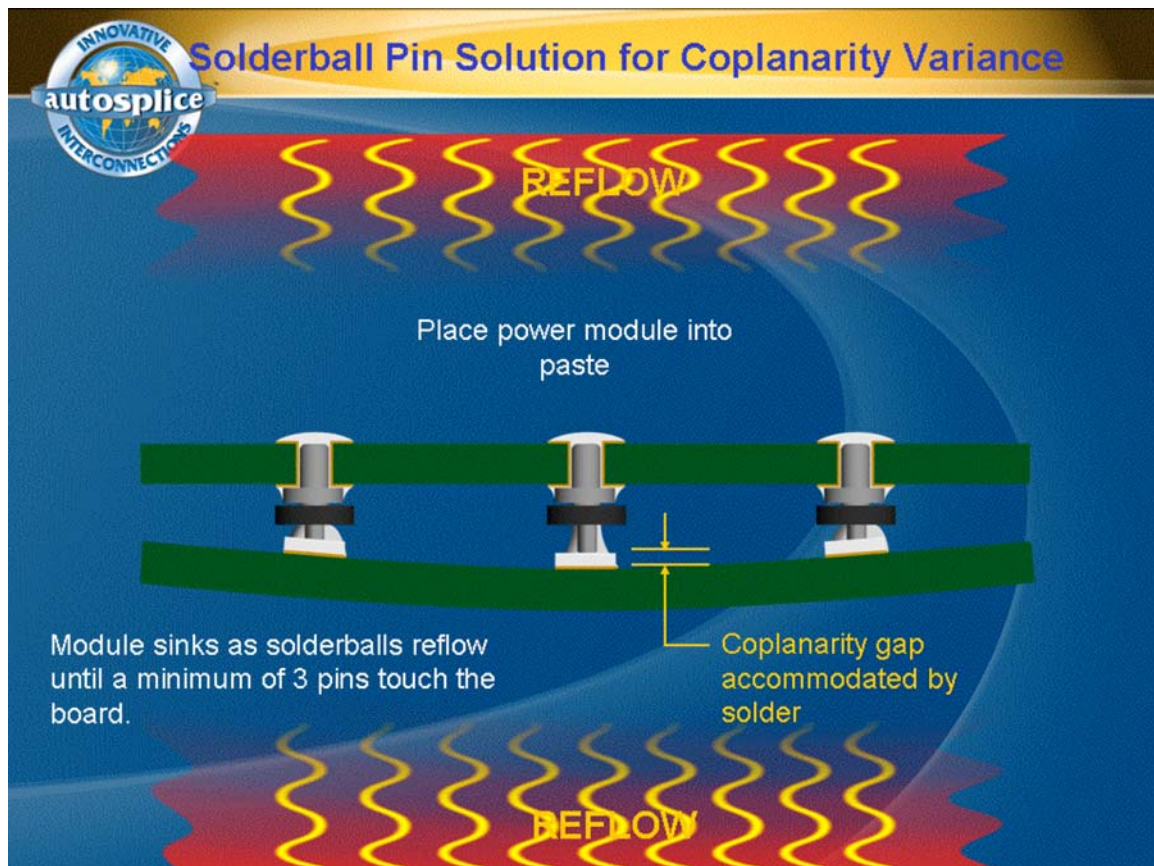


Figure 4

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Coplanarity Compensation cont.....

When the solderballs "go liquid" during reflow, the molten solder wicks and adheres to both the copper pin and the surface mount pad, forming a robust solder joint. Because the weight of the daughter module is greater than the buoyancy of the molten solder, the daughter-board module is able to settle in desired linear fashion to the standoff height of the motherboard during reflow, thus compensating for any variances in co-planarity between the PCBs.

This ability to automatically adjust for co-planarity variances during reflow means that manufacturers can gain a significant amount of "extra latitude in the process window" because all of the contacts do not have to be perfectly seated during initial placement. For example, a typical module may have between 6 and 12 discrete interconnect points, of which several points could be slightly misaligned off of the SMT pads. However, the final product would still have consistent interconnect as the upper module sinks towards the base motherboard during reflow. (See Figure 5).

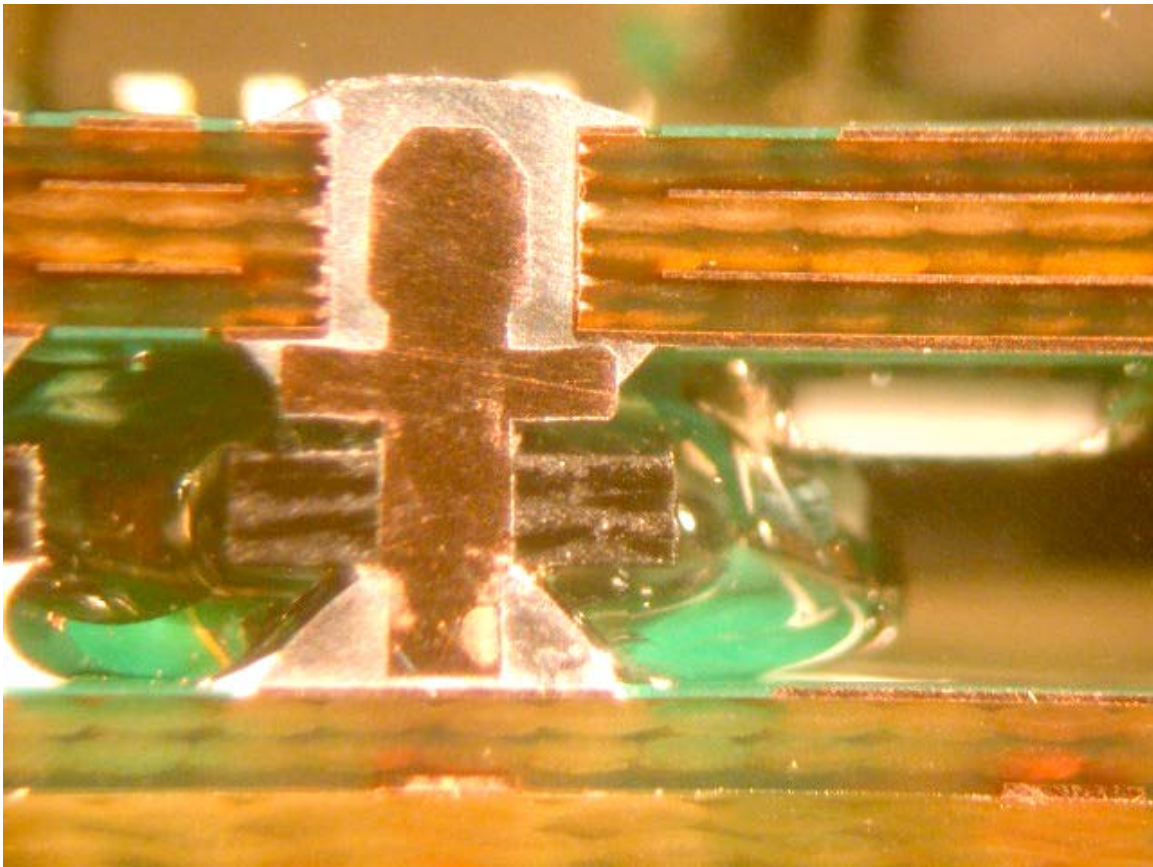


Figure 5

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Designed for Form Fit and Function

The Solderball Pin™ standard design class is developed to satisfy a variety of applications. Three main configurations are engineered [2] depending on form, fit and function, (See Figure 6). Solderball Pin™ classification is described as follows:

Micro Solderball Pin: Provides a nominal co-planarity compensation of 0.010 in. and PCB stack-up height of 0.065 in. The solder sphere diameter of 0.03 in. is recommended for a 0.065-in SMT pad. The insulator diameter is 0.06 in. × 0.025 in. thickness, and the pin tooled for 0.035-in. PCB hole sizes.

Mini Solderball Pin: Provides nominal co-planarity compensation of 0.012 in. and PCB stack-up height of 0.1 in. The solder sphere diameter of 0.041 in. is recommended for a 0.075-in. SMT pad. The insulator diameter is 0.09 in. × 0.02 in. thickness, and the pin is tooled for 0.046-in. PCB hole sizes.

Midi Solderball Pin: Provides nominal co-planarity compensation of 0.015 in. and a PCB stack-up height of 0.2 in. The solder sphere diameter of 0.071 in. is recommended for a 0.11-in. SMT pad. The insulator diameter is 0.135 in. × 0.03 in. thickness, and the pin is tooled for both 0.046-in. and 0.072-in. PCB hole sizes.

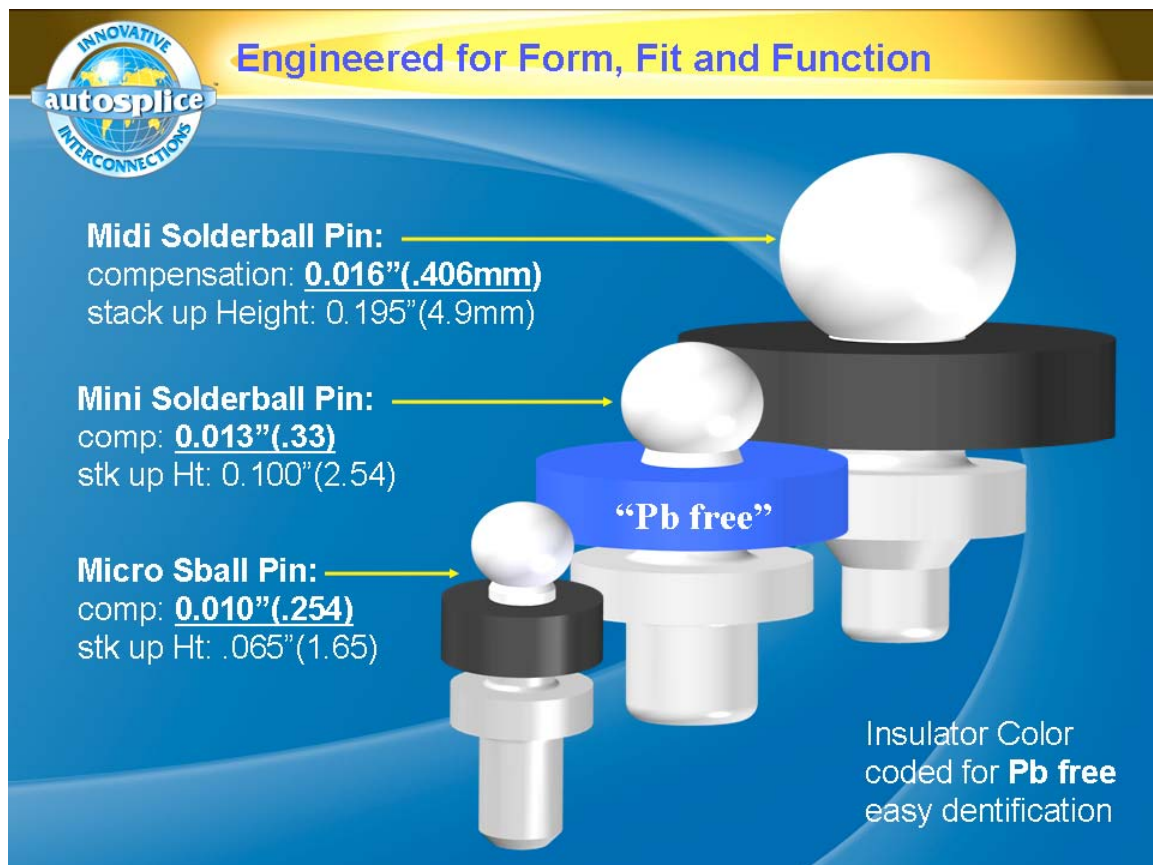


Figure 6

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Product Configuration

The Solderball Pin™ functionally replace the conventional through-hole pins, traditionally used for interconnecting the parallel PCBs, and provide a SMT-compatible solution for mounting the module to the final assembly and the solderball can comprise of regular tin-lead solder (63Sn/37 Pb), or Pb-free solder; 96.5Sn/3.0Ag/0.5Cu (SAC305). The internal pin provides a rigid, high conductivity foundation into the plated-through hole on the module PCB, while the solderball allows a physical adjustment as each solder joint is formed. The pin shoulder provides a seating plane for the annular ring on the underside of the power module PCB for pin-in-paste SMT assembly. The lower part of the pin extends through a small glass fiber insulator into a ball of solder. (See Figure 7).

The features and key characteristics are summarized as follows:

Solder sphere: Provides the attachment and interconnection with the SMT host PCB and compensates for co-planarity variances.

Insulator-seal: Provides a positive location of solder sphere during reflow. It is also the element for vacuum pick-and-place equipment.

Cu alloy pin: Provides a robust plated-through hole attachment with the PCBSA and determines the stack up height between PCBSA and host PCB.

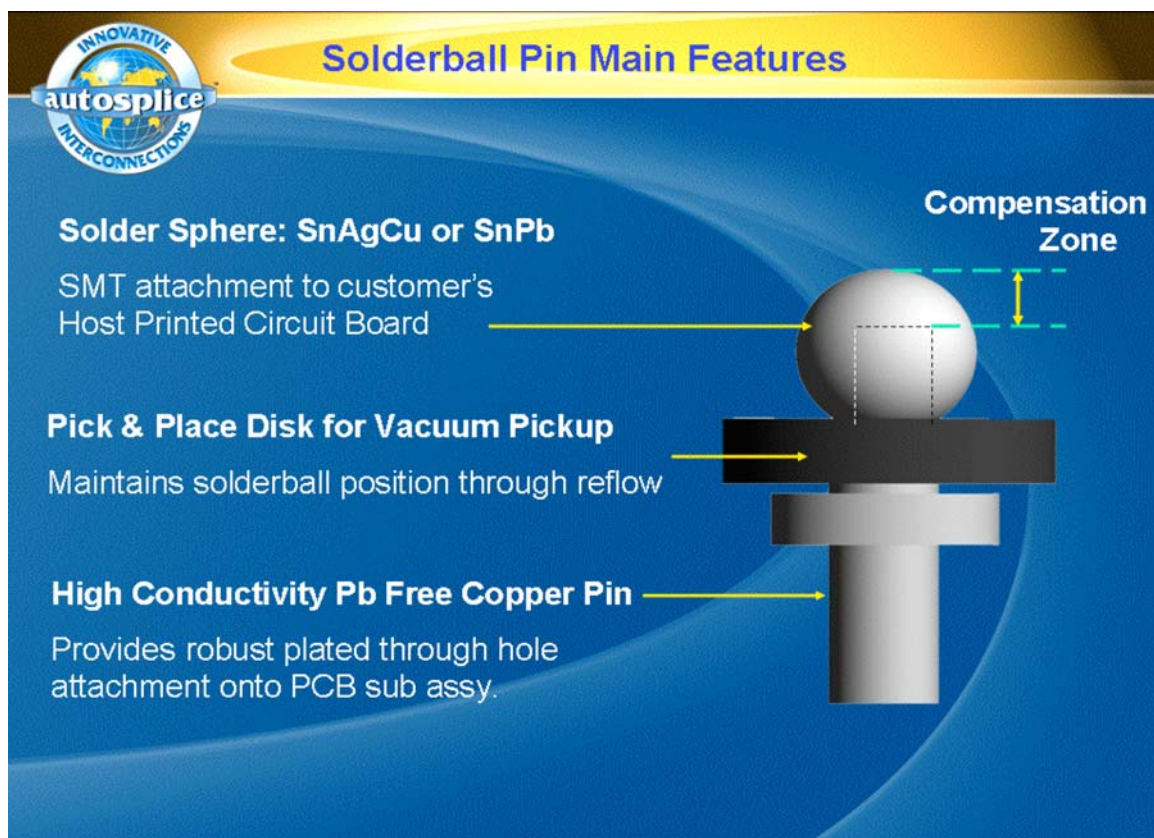


Figure 7

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Summary

The Solderball Pin™ Technology provides process simplification by enabling the same basic module designs that are used with through-hole interconnects, to be smoothly transitioned to an SMT process

When compared to other alternatives for creating module-level SMT reliable connections [4], such as floating contacts, post-forming of flex pins, or complex cladding methods, Solderball Pin™ Technology provides an inherently simple approach that leverages existing automation techniques as well as the flexibility and auto-compensation advantages of solderball technology.

Solderball pins are packaged in Tape & Reel format [5] and can be placed on the PCB module at high speed, using STD in-line placement equipment.

The adoption of this new technology translates into a cost effective interconnection approach which creates a tremendous process advantage in multiple reflow SMT Point of Load Power applications by eliminating co-planarity mismatch.

REFERENCES

- [1] IPC-A-610, Acceptability of Electronic Assemblies, Rev. D, February 2005.
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