

Compliant Technology

“Creating Robust Solderless Interconnects”

Application Notes

1.0 The Need for Automation-ready Solderless Interconnects

Creating on-board interconnect solutions is an area of significant challenge for the implementation of lead-free soldering processes. One key area for high volume manufacturers is maintaining overall production efficiency. The secondary soldering processes that have been traditionally required for attaching large connectors and other specialized interconnects are very difficult to convert to lead-free processes. This is especially challenging for heavy copper PCBs such as power interconnects.

Manufacturers are making significant progress converting “mainstream” SMT processes to lead-free but many continue to struggle with the above issues. Even before lead-free processing became a concern, secondary soldering operations have always presented difficult challenges in achieving both high productivity and volume assembly throughput. This is especially important in the automotive industry, where large molded connectors are frequently used for both power and control signals.

Manufacturers need to combine efficient automated assembly of connectors while minimizing issues associated with soldering processes. To meet this goal, Compliant technology allows high-speed machine insertion of individual or multiple interconnects that require no subsequent soldering steps and provide a high level of retention strength.

2.0 Overview of Autosplice Compliant Interconnects

Compliant pins have been around for more than 20 years, with extensive utilization in a number of

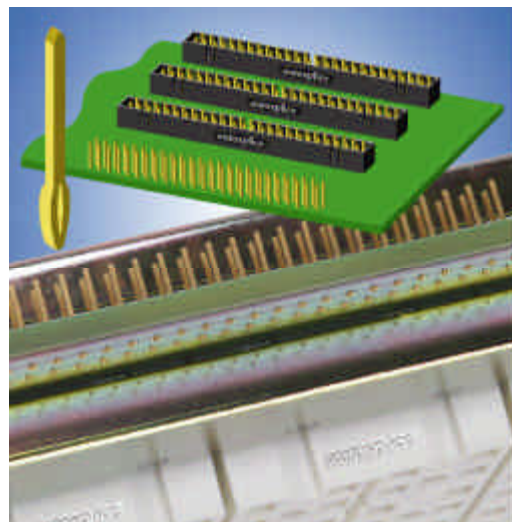
targeted markets. Compliant technology has already been proven and is widely used in the telecommunications industry in backplane PCBs (Bell-Corp 40-year-life systems architecture) such as Figure 1. In many cases, it has completely eliminated soldering for pin-intensive interconnect systems.

Driven by innovations such as described in this Applications Note, underlying compliant technologies are continually evolving to meet new challenges and address a broader range of product requirements. The following sections detail the key features of Compliant component design and discuss processing steps as well as specific application opportunities.

2.0 Compliant Design Features

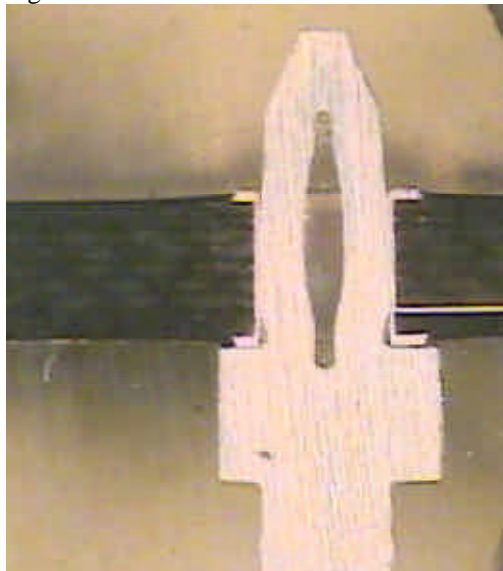
Compliant technology incorporates a special design of the insertion section of each pin, which provides a robust and reliable gas-tight interface with the plated-through hole and does not require any subsequent soldering step.

Figure 1



As shown in Figure 2, the insertion section of the pin is larger than the diameter of the hole but is designed to deform during insertion, which creates a strong friction-fit between the pin and the plated-through surface.

Figure 2



2.1 Eye-of-the-Needle Design

Over the years, a number of different design approaches have been used to provide the resilient fit necessary for compliant pins. The key challenge involves achieving the proper balance between the insertion force required and the amount of retention (e.g. the withdrawal force required to extract the pin). The objective is for the retention force to be as close as possible to the insertion force in order to assure maximum robustness of the connection.

Too much deformation of the compliant section can result in reduced normal force between the pin and the barrel of the hole, thus degrading the retention force and performance over the product's life. In addition, as compliant technology moves into new applications such as Smart Junction Boxes, in the automotive industry, it is critical that the force between the pin and the plated-through surface remain adequate to

withstand environmental and mechanical factors such as heat, humidity, vibration, shock and other rugged conditions that are inherent within an automobile environment.

The “eye-of-the-needle” approach shown in Figure 2 has been proven to provide the most reliable technology for optimizing both initial and on-going retention force. The spring-like design used in eye-of-the-needle configurations provides intimate long-term contact force against the barrel of the hole.

2.2 Gas Tight Fit with High Retention

The compliant pin's friction-fit provides a gas tight connection with sufficient retention force to maintain a high normal force on the plated through barrel of the hole, thereby eliminating the need for soldering. The interconnection is efficiently and effectively completed upon insertion.

In addition, because the compliant pin's eye-of-the-needle section resiliently absorbs the deformation of the friction fit, instead of deforming the plated-through-hole, it is also possible to remove the pin at a later point if required, without damage to the PCB or need for extensive rework.

3.0 Assembly Process Steps for Using Compliant Technology

The following sections provide a brief overview of the processing steps and issues involved with deploying Compliant Technologies.

(For more detailed information or assistance with specific application requirements, please contact Autosplice at 800-535-5538 or by emailing connect@autosplice.com.)

3.1 Designed and Packaged to Facilitate Automation

All of Autosplice’s compliant pins, blades and sockets are provided in continuously reeled formats as either individual or multiple-position connector components for insertion by high-speed automatic machines. This enables the compliant technology to be efficiently integrated within any existing SMT or through-hole processing lines.

The Compliant terminals can be automatically inserted as discrete interconnects in any required pattern, or placed as pin-header connectors, pre-cut to any required length and/or position count. Depending upon the application requirements, Compliant pin-headers are available as one-by (1 x 1, 1 x 2, etc.) or two-by (2 x 2, 2 x 3, etc.) configurations.

3.2 Solderless Insertion Step Fits Smoothly within Existing Processes

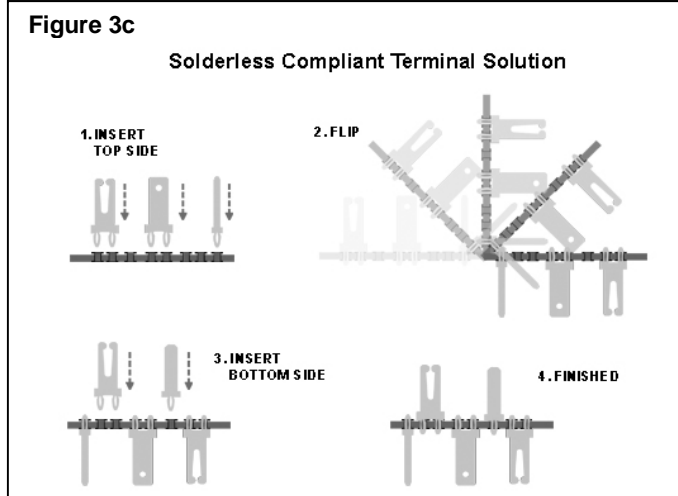
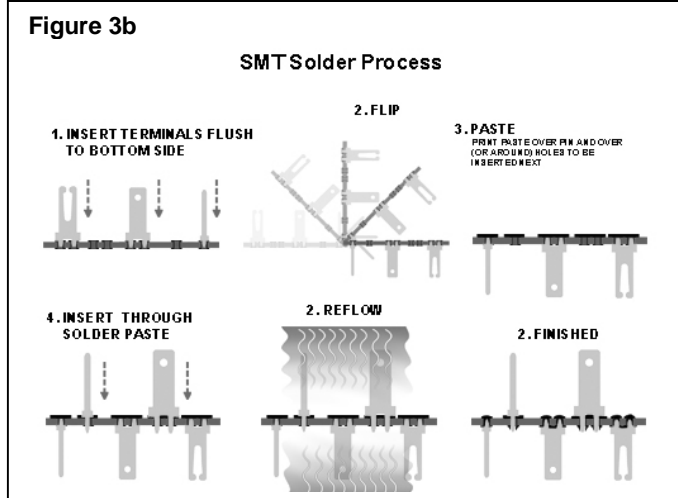
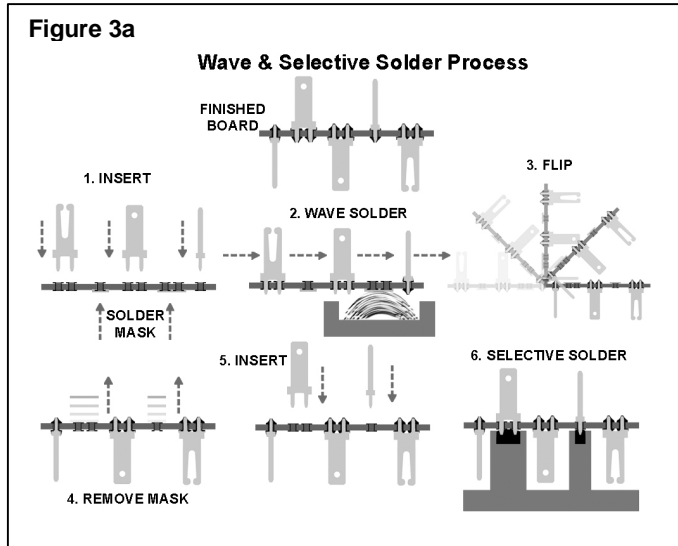
Because the solderless compliant interconnect is completely finished in a single step, the automated insertion operation can be integrated at virtually any point in the overall production flow.

Typically, the compliant pin insertion step is conducted at or near the end of the process; after all SMT components have already been placed and reflow soldered.

As shown in Figure 3, using solderless Compliant technology for on-board interconnects allows all of the SMT processes (solderpaste screening, top & bottom side component placement, reflow, etc.) to be carried out completely independent of interconnect assembly. This eliminates the costs and challenges of integrating difficult process steps such as odd-form placement of connectors, pinning through paste, secondary soldering and/or manual processes.

In addition to simplifying the overall production flow, inserting solderless interconnects as a last step also avoids the risk of scrap and costs of rework that can result from trying to manage difficult soldering processes upstream. All other

processing steps have already been completed and, upon insertion of the Compliant pins or terminals, the final assembly is done and ready for testing.



4.0 Special Applications and Quality Improvement Opportunities

Compliant technology has a number of specific benefits for accommodating special application requirements, such as the following examples.

4.1 Current-Carrying Capacity

Compliant terminals have excellent current capacity and can be especially helpful for power interconnects on heavy copper boards, which can be hard to solder and therefore are more difficult to transition into lead-free environments.

Instead of having to tweak or adjust reflow process parameters to meet special soldering challenges for heavy copper PCBs, manufacturers can establish relatively wide mainstream process control windows and eliminate special soldering requirements by using compliant interconnects for high-current applications.

4.2 Accommodating Fine-Pitch Space Constraints

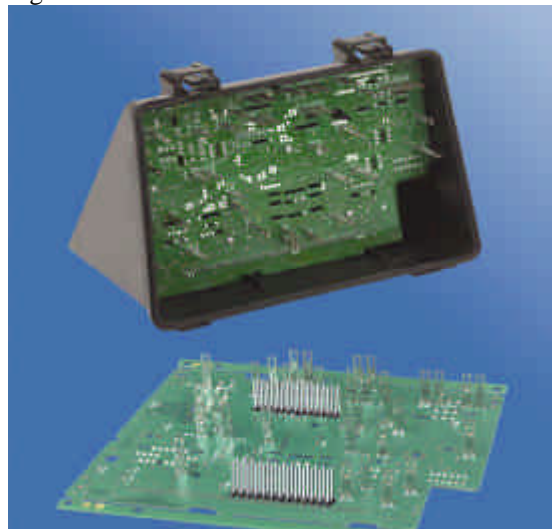
The continuing trend toward fine-pitch SMT designs is also made easier by using compliant pin technology. As the spacing between connections gets smaller, the soldering challenges increase significantly. Deposition of solder paste must be held within very tight tolerances to avoid bridging or solder-balling between pads and the overall process must be more tightly controlled. This drive to minimize solder volumes directly conflicts with SMT and pin in paste connector requirements, which often need larger solder fillets to assure the robustness for external physical connecting forces. Compliant pins allow the manufacturer to completely eliminate the hassles, specialized equipment and extra costs associated with soldering connectors on small fine-pitch SMT boards.

4.3 Facilitating Smart Junction Box (SJB) Design & Assembly

As Compliant technology migrates into new application arenas, the combination of solderless

connections, process flexibility and overall efficiency is enabling new design approaches that spur continued integration of multiple functions. For example, in the automotive industry, the trend toward Smart Junction Boxes (see Figure 4) is being supported by the use of compliant interconnects that make it easier for both electronic controls and power distribution functions to be integrated within the same device.

Figure 4

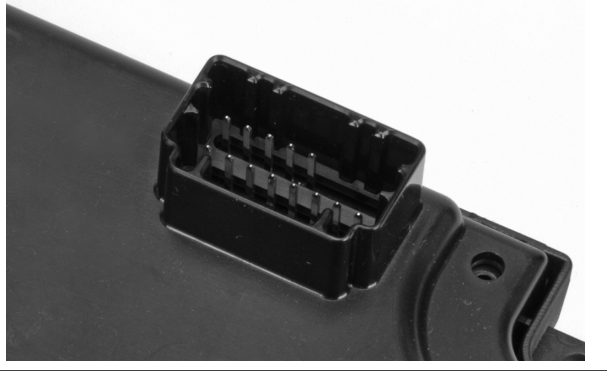


4.3 Eliminating Molded Connectors

In some applications, the ability to insert compliant contacts directly into the PCB using any specified pattern can even eliminate the need for separately molded connectors, thereby further reducing overall size, weight and cost. In effect, the automated insertion process is able to “dynamically build” a multi-pin connector right on the PCB, after which the entire assembly can be enclosed with a single outer shell, with the connector pins protruding out through appropriately placed openings. (See Figure %)

For situations where separate connectors are more appropriate, the connector assemblies themselves can be designed with compliant technology so that the entire connector can be pressed into the board after the soldering process has been completed.

Figure 5 – Compliant Pins Extending through Assembly's External Shroud



5.0 Tested for Reliability, Retention Strength & Environmental Resistance

Autosplice eye-of-the-needle Compliant technologies have been extensively tested to assure compliance with a number of key industry requirements, including SAE/USCAR-2, Rev4, EIA Publication 364 and IEC 60352-5 specifications. The testing process used systematic evaluation of environmental, mechanical and reliability factors under controlled conditions.

Testing was conducted for a range of different Compliant interconnects and PCB types (including copper plating, gold plating and HASL finish). All test samples were fabricated and assembled utilizing normal production techniques and quality criteria.

Specific testing included vibration, thermal shock & thermal life, mechanical shock, insertion force, retention strength, humidity, current cycling and contact resistance. All interconnect designs consistently passed with no damage and/or conformance with specified parameters. *(Complete test results are available upon request.)*

6.0 Compliant Pin Specifications, Configurations, Options

Compliant interconnects are currently available from Autosplice in the following configurations:

- Discrete terminals (blades, tabs, etc.)
- Continuous-reeled pins
- Pin headers on continuous reels or pre-cut lengths (one-by or two-by)
- Square or round (industry standard or custom diameters & pin lengths)

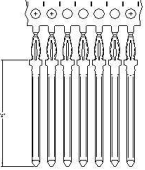
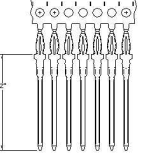
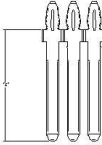
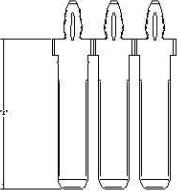
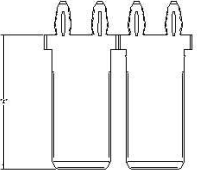
(For more detail, see Appendix)

6.0 Benefits Summary

- Automation-friendly solderless interconnect assembly process
- Elimination of inefficient secondary soldering processes
- Gas-tight solderless connections
- High level of in-board retention force
- Excellent current-carrying capabilities
- Streamlined transition to lead-free

Appendix:

Listing of Specific Compliant terminals tested to USCAR and EIA Specifications

Compliant Pin part number	Pin Dimensions
7-V5004-015TT 	0.64mm thick x 1.0mm wide (0.025" x 0.039")
7-V5007-015TT 	0.64mm thick x .64mm wide (.025" x .025")
7-V5005-015TT 	0.81mm thick x 1.5mm wide (0.0315" x 0.059")
7-V5006-015TT 	0.81mm thick x 2.8mm wide (0.0315" x 0.110")
7-V5008-015TT 	0.81mm thick x 6.0mm wide (0.0315" x 0.236")