ReadyStack – A Stackable Mezzanine-Style Interposer for Board-to-Board Applications

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INTRODUCTION

Solderless compression interposers are a type of electrical interconnection that differs from traditional pin-and-socket mezzanine connectors, which are commonly used to pass signals between printed circuit boards (PCBs). While conventional mezzanine connectors typically feature a male (pin) side and a female (socket) side, solderless compression interposers use a different mechanical and electrical design. They connect PCBs without soldering, relying on spring-loaded contacts, or spring probes, to secure the connection. This approach offers advantages such as easier assembly, reduced risk of solder-related issues and the ability to reconfigure or replace boards without desoldering.

A spring probe is typically composed of three to four distinct components, depending on its design and intended application. The plunger is the movable contact element that physically engages with the PCB pad to establish the electrical connection. The barrel serves as the housing for the plunger and spring, providing mechanical support and a structural platform for high-speed RF signaling. Together, these components form a compact, reliable interface for making and breaking electrical connections in high-frequency environments, making spring probes a common choice for high-reliability applications.

Solderless spring-loaded interposers tend to be bespoke solutions and are designed specifically for the application. A typical design cycle for an interposer is to scope the product's mechanical, electrical and environmental requirements. The next step in the process is to design the interconnect and get customer approval. Once the design has been agreed upon, the product is taken into the prototype phase and the product is manufactured. The product will likely go through production screening and qualification. If the qualification fails, it could lead to multiple iterations of design and qualification. Although this development cycle and its costs are acceptable when developing medium Earth orbit (MEO) and geostationary Earth orbit (GEO) satellites that have budgets that can exceed 500 million euros, low Earth orbit (LEO) satellites generally have budgets that are anywhere from 1 to 10 million euros and must use commercial off-the-shelf (COTS) components to stay within budget. These satellites are used for non-mission-critical and non-safety-critical applications.

Smiths Interconnect, a Molex company, has developed a new interposer solution called ReadyStack. Based on an alternative contact technology, the proprietary H-Pin technology, ReadyStack is intended as a COTS solution. The H-Pin, shown in Figure 1, is a stamped metal contact that is manufactured in high volumes with automated assembly. The stamped blades have two forks that, when assembled, are rotated 90° from each other and maintain contact with each other throughout the range of travel, resulting in low and reliable contact resistance like spring probe technology. The spring provides the force, approximately 35 grams, needed to achieve good contact resistance but is not the path for the electrical current when cycled.



Figure 1 H-Pin

The H-Pin contacts also exhibit strong current-carrying characteristics relative to their size. In a compressed state, the contact height is 3.75mm and can carry up to 4.0A DC. Two key areas that differentiate spring probe technology from H-Pin technology are RF performance and cycle life.

Figure 2 below shows the typical resistance of a spring probe as it is cycled. The graph shows resistance and standard deviation across its cycle life. The standard deviation remains consistent through 100,000 mating cycles.

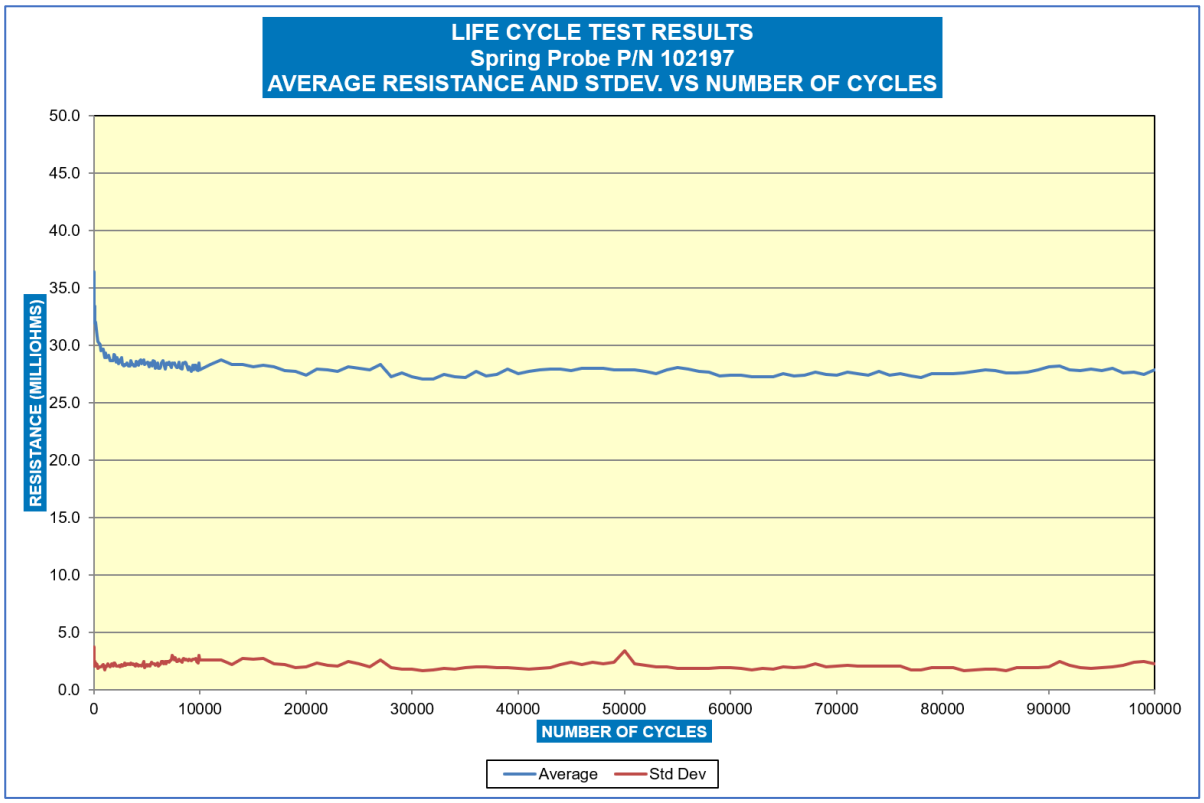


Figure 2 Typical spring probe performance

The resistance of the H-Pin is shown below in Figure 3. The H-Pin resistance and standard deviation become unstable at approximately 25,000 cycles.

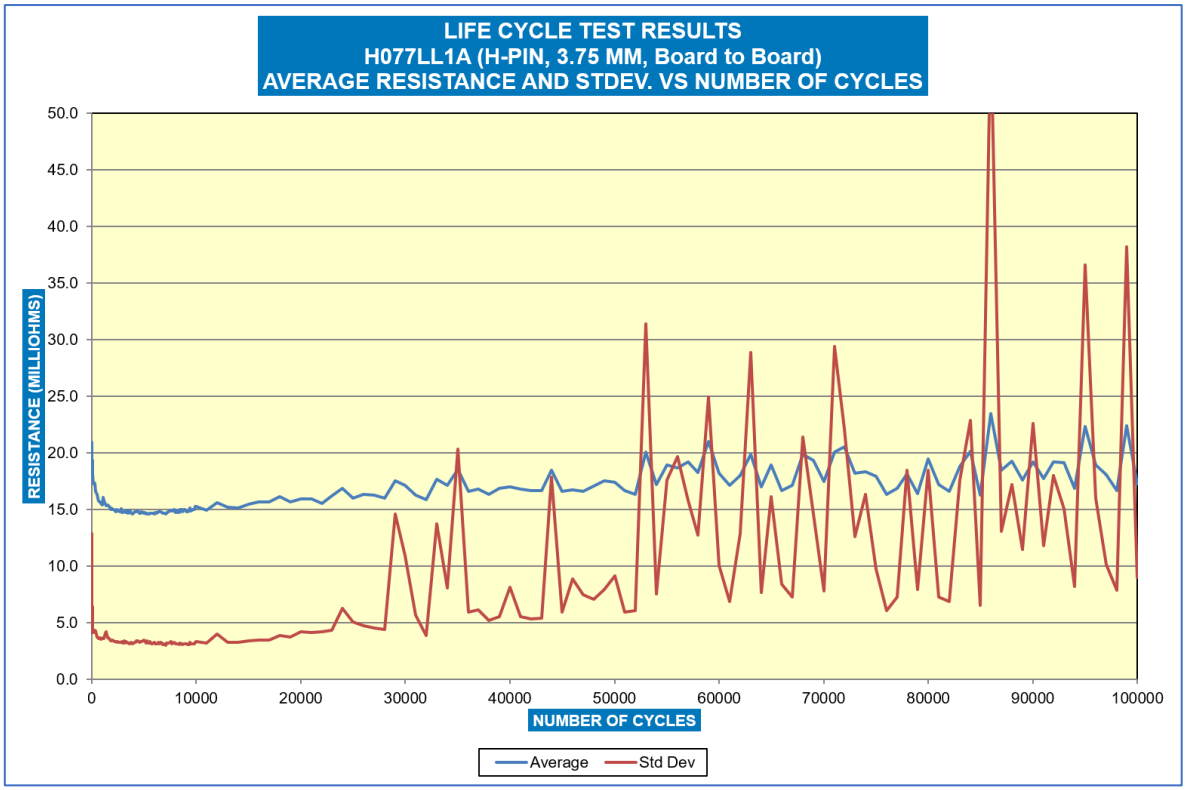


Figure 3 Typical H-Pin performance

The RF performance of the H-Pin is not as strong as that of a typical spring probe due to its flattened construction. The graph shown in Figure 4 shows a comparison of the single-ended insertion loss between the spring probe and the H-Pin. The pins were configured in a rectangular array with the center pin used as the signal conductor and the outer pins serving as grounds. This configuration represents the optimal arrangement for RF performance. The blue line in the graph shows the insertion loss of the H-Pin, which begins to resonate at 10 GHz and then drops below -3 dB at 20 GHz. The orange line shows the RF performance of a typical spring probe, crossing the -1 dB point at approximately 39 GHz and dropping below -3 dB at approximately 47 GHz.

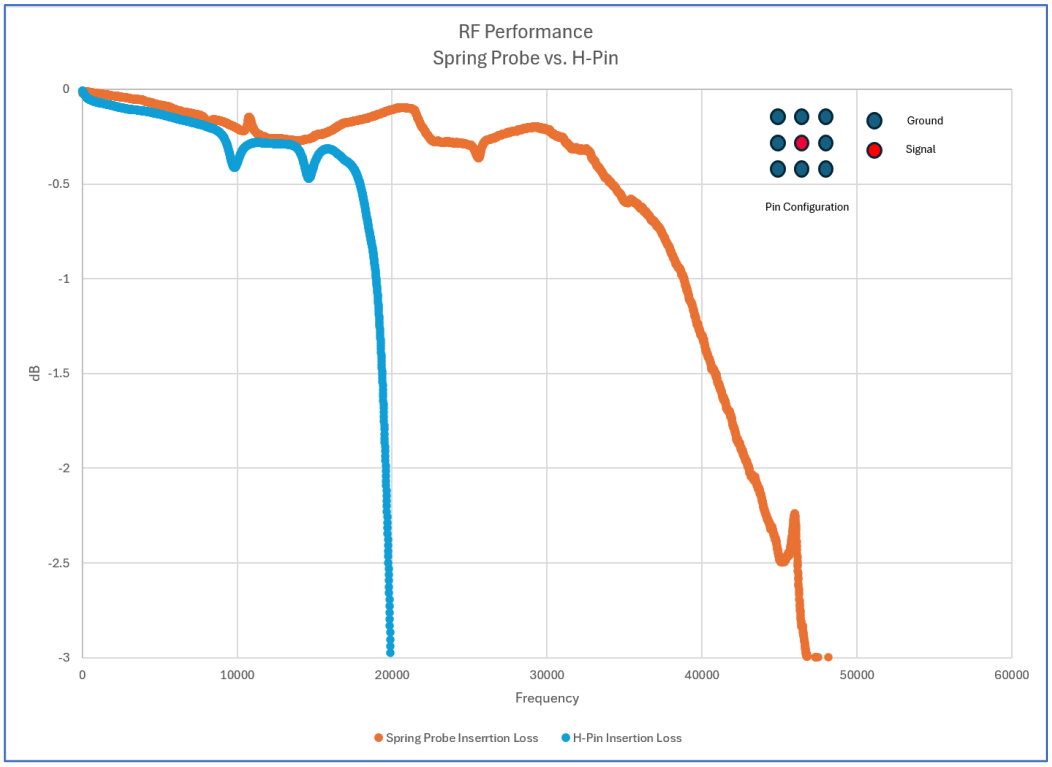


Figure 4 Spring probe vs. H-Pin RF performance

COTS Product

Smiths Interconnect, a Molex company, has incorporated its signature H-Pin technology into standard 50-way, 100-way, and 200-way interposers that are commercially available for purchase (see Figure 5). Another feature implemented in the design is called the "Top Hat". The Top Hat is a solid pin that sits on top of the H-Pin to extend its overall length. Figure 6 shows a cross-section of the Top Hat configuration.

The interposers are offered in base configurations with a 3.75mm board-to-board height. Additional configurations begin at 6mm, with Top Hats increasing in 2mm increments up to a 20mm board-to-board height.

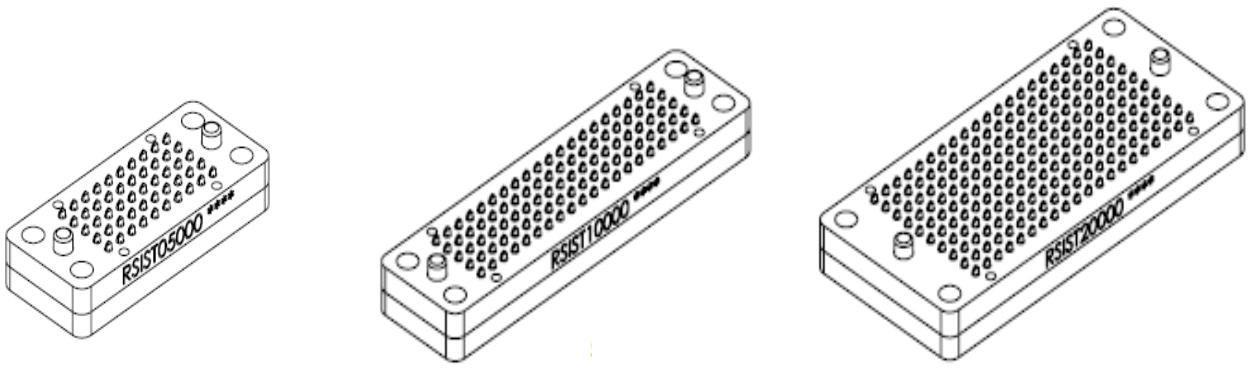


Figure 5 ReadyStack configurations

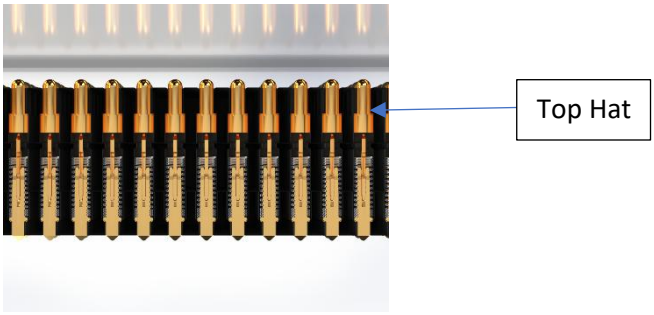


Figure 6 Top Hat solution

Qualification

In preparation for product launch, a side-by-side qualification was conducted against a spring probe interposer in accordance with MIL-DTL-55302, a generic qualification standard for rectangular connectors. Three interposers equipped with standard H-Pin contacts and three interposers of the same configuration with Top Hats at the maximum board-to-board height of 20.00mm were tested, along with equivalent spring probe interposers. Table 1 below shows the sequence of tests performed on all samples.

Test Procedure	Paragraph Reference	Pass/Fail Criteria	
Subgroup 1 – All DUT #s (All Connector Samples)		**Pass/Fail Criteria**	**Pass/ Fail**
Visual and mechanical	10.1	Free from defects, meet drawing requirements, H-Pins and spring probes move freely	Pass
Mating and unmating	10.2	No damage to contacts	Pass
Contact resistance	10.3	< 50 milliohm (short) & < 75 milliohm (long)	Pass
Low-level contact resistance	10.4	< 50 milliohm (short) & < 75 milliohm (long)	Pass
Dielectric withstanding voltage	10.5	< 5 mA leakage current @ 750V DC – ref. only	Pass
Insulation resistance	10.6	≥ 5,000 Megohm @ 250V DC – ref. only	Pass
Visual and mechanical	10.7	Free from defects, meet drawing requirements, H-Pins and spring probes move freely	Pass
Subgroup 2 – DUTs #1, #4, #7, #10 (1/3 of Connector Samples)		**Pass/Fail Criteria**	
Dielectric withstand voltage at high altitude (70,000 ft.)	11.1	< 5 mA leakage current @ 300V AC – ref. only	Pass
Mating and unmating	11.2	No damage to contacts	Pass
Low-level contact resistance	11.3	< 50 milliohm (short) & < 75 milliohms (long)	Pass
Vibration	11.4	No discontinuities ≥ 1 ns	Pass
Shock (specified pulse)	11.5	No discontinuities ≥ 1 ns	Pass
Low-level contact resistance	11.6	< 50 milliohms (short) & < 75 milliohms (long)	Pass
Contact resistance	11.7	< 50 milliohms (short) & < 75 milliohms (long)	Pass
Dielectric withstand voltage	11.8	< 5 mA leakage current @ 750V DC – ref. only	Pass
Insulation resistance	11.9	≥ 5,000 Megohms @ 250V DC – ref. only	Pass
Visual and mechanical	11.10	Free from defects, meet drawing requirements, H-Pins and spring probes move freely	Pass
Subgroup 3 – DUTs #2, #6, #8, #11 (1/3 of Connector Samples)		**Pass/Fail Criteria**	
Thermal shock	12.1	5 cycles, -55 to +165°C (30 min. dwell at each temperature extreme)	Pass
Low-level contact resistance	12.2	< 50 milliohms (short) & < 75 milliohms (long)	Pass
Dielectric withstand voltage	12.3	< 5 mA leakage current @ 750V DC – ref. only	Pass
Insulation resistance	12.4	≥ 5,000 Megohms @ 250V DC – ref. only	Pass
Mating and unmating	12.5	No damage to contacts	Pass
Humidity	12.6	Insulation resistance ≥ 1 Megohm after step 6 of the final cycle – (IR portion is ref. only)	Pass
Low-level contact resistance	12.7	< 50 milliohms (short) & < 75 milliohms (long)	Pass
Insulation resistance	12.8	≥ 5,000 Megohms @ 250VvDC – ref. only	Pass
Visual and mechanical	12.9	Free from defects, meet drawing requirements, H-Pins and spring probes move freely	Pass

Errore. L'origine riferimento non è stata trovata. *Tests sequence*

Shock and Vibration

The two principal areas of concern with the H-Pin were its response to shock and vibration. Vibration testing was performed in accordance with EIA-364-28, Test Condition IV. The test samples were fully mated between a pair of PCBs. The test specimens were subjected to a sine sweep with a maximum of 20 g peak. The test frequency was swept between 10 Hz and 2,000 Hz and back to 10 Hz; each sweep duration was 20 minutes. This cycle was performed 12 times in each of three mutually perpendicular directions (a total of 36 times), so that the motion was applied for a total period of 12 hours. An electrical load of 100 mA (max.) was applied with a detector capable of detecting a discontinuity of 1 nanosecond or longer. No discontinuities were detected throughout the test.

The same interposers that were exposed to vibration were exposed to shock. They were tested per EIA-364-27, Test Condition G. The test samples were fully mated between a pair of PCBs. Test specimens were subjected to a sawtooth shock pulse that had a peak acceleration of 100 g. There was one blow applied for each positive and negative direction along each of the three mutually perpendicular axes for a total of six shocks per device under test (DUT).

An electrical load of 100 mA maximum was applied with a detector capable of detecting a discontinuity of 1 nanosecond or longer. No discontinuities were detected.

SUMMARY

ReadyStack interposers, featuring H-Pin technology, are designed in 50-, 100-and 200-way configurations for transmitting signals between two PCBs. Tests have shown that spring probe interposers, also offered by Smiths Interconnect, a Molex company, continue to outperform most other interposer technologies. Even if design cycles for spring probe solutions can last for months, spring probes remain essential for solving complex board-to-board interconnection challenges. Additionally, the new ReadyStack interposers employ Top-Hat technology, enabling configurable board-to-board heights from 3.75 to 20.00mm and providing a reliable, flexible, commercially available solution with a lower cost. They are rated up to 25,000 mating cycles, which exceeds the performance of most other interposer technologies but remains below that of spring probe interposers. ReadyStack interposers are band limited in RF to 10 GHz whereas spring probe interposers can operate well beyond 40 GHz.

ReadyStack interposers equipped with H-Pin contacts and Top Hats passed qualification to MIL-DTL-55302 and maintained nanosecond-level continuity throughout shock and vibration testing. The ReadyStack product line lays the foundation for a cost-effective COTS solution for board-to-board applications.