

Spring Probe Technology

Smiths Interconnect is the world leader in spring probe design and the industry's expert in applying spring probes as interposer contacts. Spring probes are an enabling technology that fundamentally change the capabilities of the products in which they are incorporated.



Low Profile, High Compliance Ratio

Spring probe technology permits an exceptionally high compliance-to-length ratio. This allows Smiths Interconnect to design interposers as compact as 0.08" (2.00 mm), while maintaining 0.02" (0.50 mm) of compliance.

Reliability in Harsh Environments

The durable nature of Smiths Interconnect spring probes ensures interposers that are designed for high performance in the harshest conditions. Whether environmental factors like shock, vibration, salt, sand, dust, heat or the vacuum of space, Smiths Interconnect delivers a reliable, fail-safe connection.

Low, Stable Resistance

Smiths Interconnect spring probes feature several innovations for control of DC performance and high speed capabilities. Advanced biasing techniques provide excellent stability of contact resistance, even under conditions of heavy shock and vibration.

Extreme Density

Smiths Interconnect spring probes require no mating half and can be designed to very small diameters, 0.039" (0.99 mm), allowing maximum density in an array pattern.

High Cycle Life

Smiths Interconnect's extensive plating and materials knowledge, combined with engineering expertise, delivers contacts that exceed the highest expectations for insertion life. Based on the design, spring probes are capable of remarkable longevity from 20,000 to 300,000 cycles.

Ideal for Blind Mate

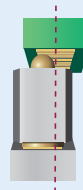
Spring probe interposers are compliant, allowing unique blind mate capabilities. Designed to engage and disengage to its target at a 90° angle, probe technology is an ideal approach for quick-disconnect applications for system repair or replacement.

High Frequency

Smiths Interconnect spring probes incorporate a short signal path ensuring excellent signal integrity for both analog and digital applications.

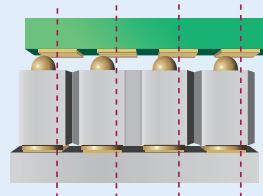
Accommodates Target Misalignment

Spring probes are compliant and require only a flat pad as their target. Contact is maintained as long as the probe tip touches any point within the target. This ensures forgiveness of any X, Y, Z, angular or rotational misalignment.



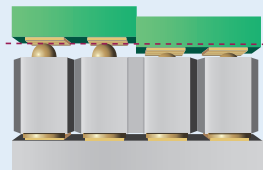
X Misalignment

Probes are moved from the x-axis but connection is not affected.



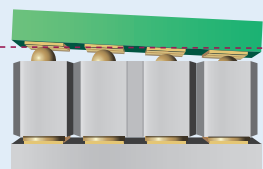
Y Misalignment

Probes are moved from the y-axis but connection is not affected.



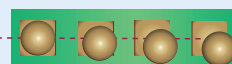
Z Misalignment

Probes are engaged from different z-axis points without impacting performance.



Angular Misalignment

Probes are engaged at varying angles.



Rotational Misalignment

Probes are rotated from the target's center.

Features and Benefits

Utilizes low profile, high density spring probe technology

- Low, stable contact resistance throughout long insertion life
- Optimal signal integrity ≥ 40 GHz
- Accommodates reduced package size or footprint
- Advanced biasing techniques for RF power handling and elevated current carrying capacity
- High compliance with 1:3 travel to length ratio
- Reliable performance under conditions of heavy shock and vibration without contact interruption
- Renowned longevity in the field without sacrificing performance
- Advanced materials and plating expertise

Compression mount termination options

- Easy, solderless installation and removal
- Allows for effortless mating and demating
- Provides a dependable direct connection eliminating the need for cabled solutions

Design flexibility

- Broad range of spring probe designs
- Spring probe technology applied in a wide array of patterns to meet precise mechanical and electrical specifications
- Rapid prototyping capabilities
- Robust packaging for easy handling and maintenance
- Ingress protection to IP68 and MIL-810 available

Spring probe arrays configured to match required footprint

- Efficient utilization of board space
- Easy trace routing

Integrated alignment, latching and sealing features

- Prevents improper mating
- Ensures component clearance
- Protects against contamination ingress

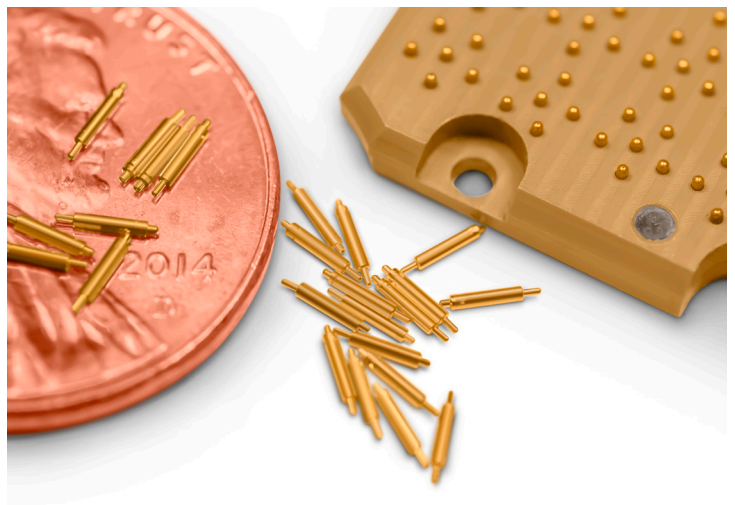
Interposers

Smiths Interconnect integrates industry-leading spring probe technology with extensive design experience to provide application-specific interposer solutions. Whether facing intense shock and vibration, extreme temperatures or environmental contaminants, Smiths Interconnect tailors every solution to operate at peak performance without contact interruption.

Smiths Interconnect interposers can be soldered or compression mounted enabling a reduction in manufacturing costs and providing space savings in a confined area. Interposers can be designed to handle substantial amounts of power safely with some individual contacts capable of withstanding as much as 30 Amps in free air.

Utilized throughout the aerospace industry, Smiths Interconnect interposers are incorporated in applications such as:

- Ground and air-based radar
- Satellites
- Missiles
- Fixed wing and rotary aircraft
- Test and measurement environments



A comprehensive discussion with the Smiths Interconnect team initiates the design process. Time is invested to understand the electrical, mechanical and environmental requirements of the project. Leveraging a broad portfolio of spring probe products with state-of-the-art modeling and simulation tools, the ideal Smiths Interconnect spring probe is recommended for the interposer. Consideration is given to the mating environment and additional aspects, such as component cut-outs, sealing gaskets, housing materials and alignment features, are suggested to complete the proposal.

Smiths Interconnect embraces a collaborative approach to ensure delivery of an innovative, high performance, reliable interposer which meets each customer's specifications while exceeding their expectations.

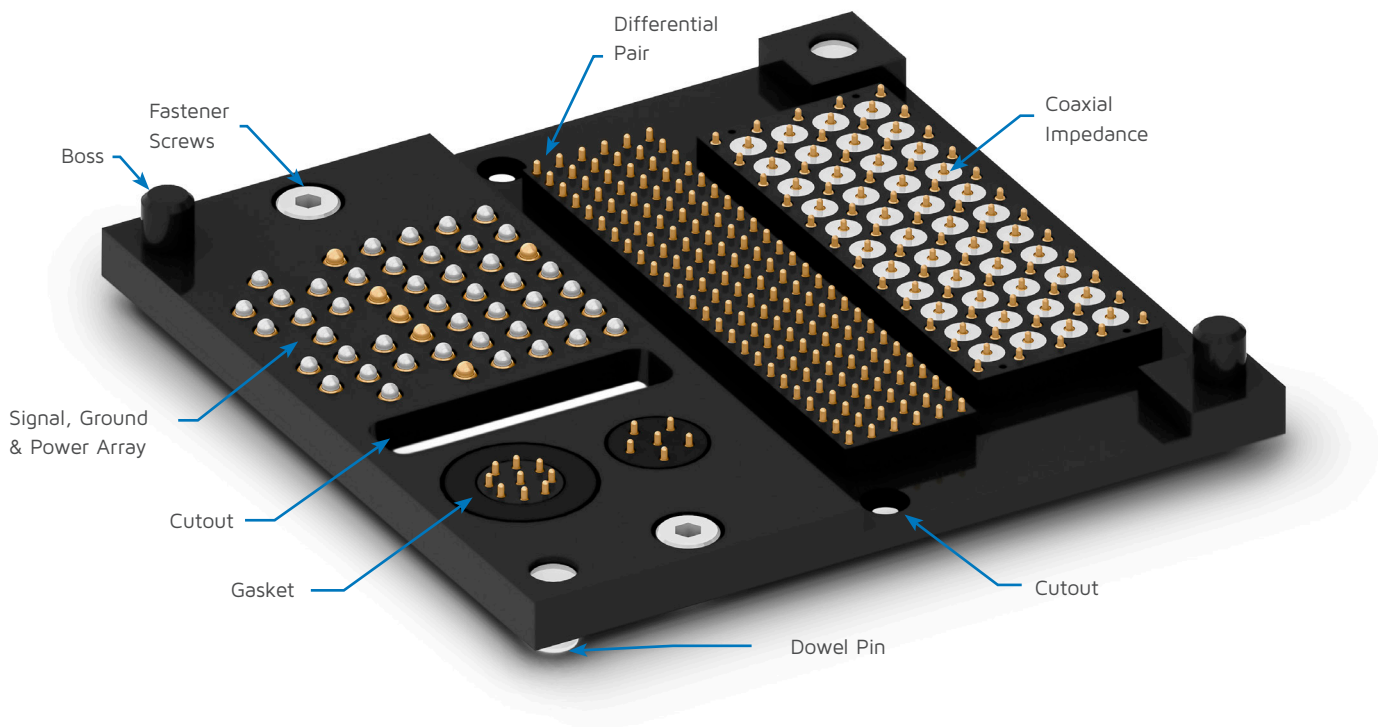
Custom Interposer Features

Alignment, Housing, Sealing & Termination Options

Smiths Interconnect custom interposers are designed to ensure industry-leading reliability and performance with the flexibility to incorporate application-specific features.

Through our unique design process, each interposer is specially developed using the following steps with guidance from our Field Applications Engineers and technical support teams.

- 1 A spring probe meeting board spacing, pitch and electrical requirements is selected from our broad portfolio (see pages 6-9).
- 2 The housing material is identified considering its dielectric constant. Prototypes are typically designed with machined plastics that have molded equivalent options.
- 3 The spring probe layout is defined utilizing RF simulation as needed to maximize signal integrity.
- 4 Any additional options such as gaskets, markings, alignment features and packaging requirements are specified.



Signal Patterns

In analyzing an application, specific probe and array configurations are recommended to perfectly balance the footprint requirements with optimal electrical performance.

Coaxial Impedance

Achieved with an array pattern design or introduction of a dielectric

Differential Pair

Two complimentary contacts with equal and opposite signals

Spring Probe Arrays

Signal, power, ground/return pins, and mixed signal configurations

Alignment Features

To ensure compatibility with the customer's exact footprint, Smiths Interconnect utilizes precision-machined and molded housing features. This allows for accurate mating orientation, as well as clearance of board components.

Dowel Pins

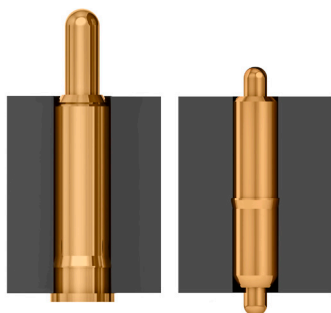
Stainless steel guide posts

Bosses

Molded stud features

Cutouts

Slot or hole which avoids a board feature or provides clearance for other components



Contact Terminations

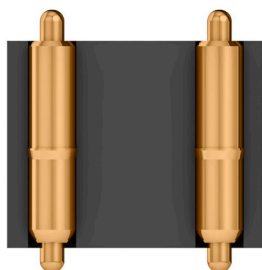


Figure 1: One-Piece Housing with Fixed Probe

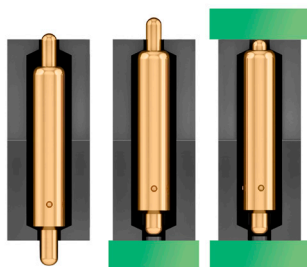


Figure 2a: Cross Section of Two-Piece Housing with Floating Probe

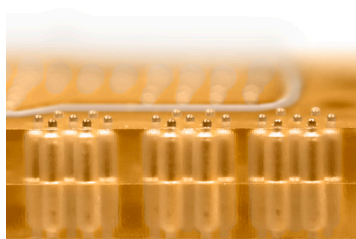


Figure 2b: Photo of Two-Piece Housing with Floating Probe

Contact Terminations

Smiths Interconnect offers termination options that are designed to amplify the unique advantages of our interposers.

Surface Mount

Smiths Interconnect surface mount interposers integrate easily with modern manufacturing processes. This style is soldered into place while still maintaining a low profile structure.

Compression Mount

Smiths Interconnect compression mount solutions utilize spring probe compliance to ensure a reliable electro-mechanical connection. This solderless solution greatly simplifies the manufacturing process while providing significant space savings.

Housing Styles

Smiths Interconnect interposers are designed with single or double-ended spring probes and populated within either one or two-piece housings.

1-Piece Housing (Fixed Probe)

One-piece housings are populated with spring probes featuring a barb on the barrel allowing them to be press-fit within the housing (Figure 1). This holds the barrel of the probe motionless within the housing while the plungers are compliant against the printed circuit boards.

2-Piece Housing (Floating Probe)

Two-piece housings are designed with spring probes that float within the housing (Figures 2a and 2b). Contact is achieved when the probe is mounted and compressed ensuring compliance to both boards.

Housing Materials

Smiths Interconnect can accommodate delivery requirements through all stages of program development from prototype through low run initial production into high volume manufacturing. We employ a variety of housing materials depending on the application.

Machined

PEI (polyetherimide, e.g. Ultem®), PAI (polyamide-imide, e.g. Torlon®), brass, aluminum

Molded

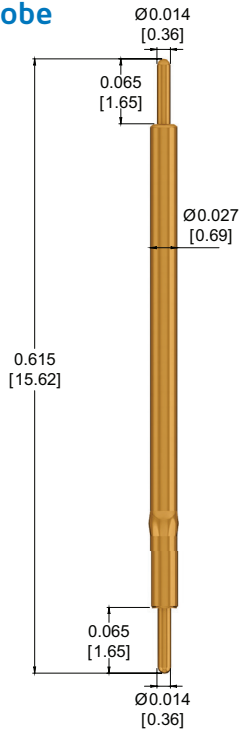
LCP (liquid crystal polymer, e.g. Vectra®), PPA (polyphthalamide, e.g. Amodel®), PS (polyphenylene sulfide, e.g. Ryton®)

Interposer Probe Portfolio

Dimensions and Specifications

The following pages highlight Smiths Interconnect interposer probe portfolio. This information is intended as a reference for interposer design specification only as these probes are not available for individual purchase. Other designs may be available. Consult a Smiths Interconnect technical expert for more information.

500033 Probe



Probe Specifications

Part Number	500033-000
Minimum Centers	0.039 (0.99)
Current Rating	3 A continuous (individual probe in free air at ambient temperature)
Spring Force	1.9 oz (54 g) @ 0.080 (2.03) travel
Typical Resistance	< 30 mΩ
Maximum Travel	0.104 (2.64)
Working Travel	0.080 (2.03)

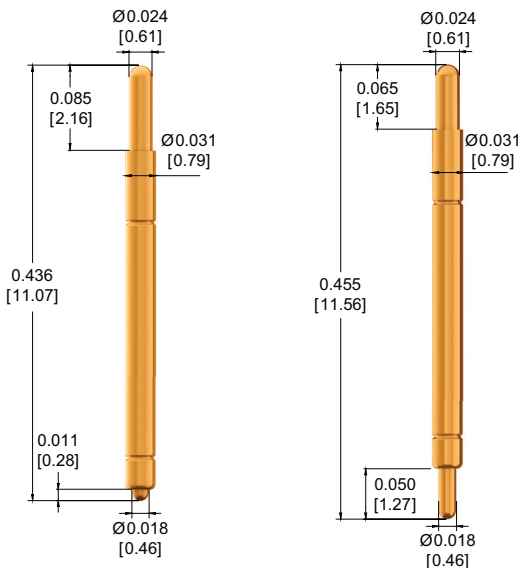
Materials

Barrel	Nickel silver, gold plated
Spring	Stainless steel, gold plated
Plunger	Beryllium copper, gold plated

101367 Probe

101367-001

101367-002



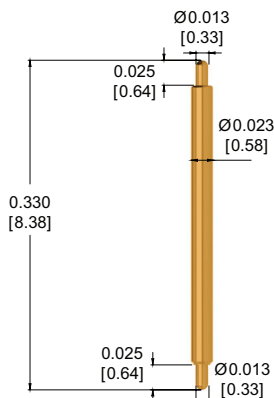
Probe Specifications

Part Numbers	101367-001 (OAL: 0.436") 101367-002 (OAL: 0.455")
Minimum Centers	0.039 (0.99)
Current Rating	5 A continuous (individual probe in free air at ambient temperature)
Spring Force	3.7 oz (105 g) @ 0.030 (0.76) travel
Typical Resistance	< 25 mΩ
Maximum Travel	0.057 (1.45)
Working Travel	0.030 (0.76)

Materials

Barrel	Nickel silver, gold plated
Spring	Stainless steel, gold plated
Plunger & Post	Beryllium copper, gold plated

500057 Probe



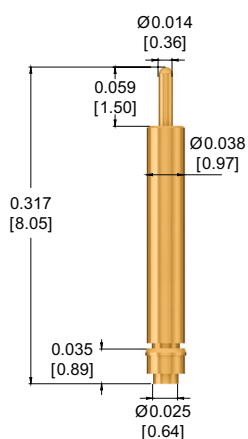
Probe Specifications

Part Number	500057-000
Minimum Centers	0.039 (0.99)
Current Rating	3 A continuous (individual probe in free air at ambient temperature)
Spring Force	3.5 oz (99 g) @ 0.050 (1.27) travel
Typical Resistance	< 10 mΩ
Maximum Travel	0.050 (1.27)
Working Travel	0.050 (1.27)

Materials

Barrel	Nickel silver, gold plated
Spring	Stainless steel, gold plated
Plunger	Beryllium copper, gold plated

500781 Probe



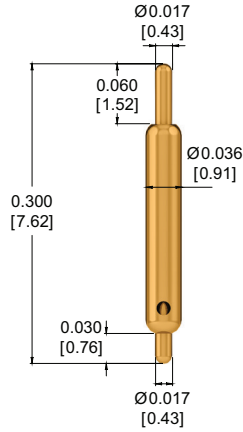
Probe Specifications

Part Number	500781-001
Minimum Centers	0.055 (1.40)
Current Rating	9 A continuous (individual probe in free air at ambient temperature)
Spring Force	2.8 oz (79 g) @ 0.039 (0.99) travel
Typical Resistance	< 15 mΩ
Maximum Travel	0.059 (1.50)
Working Travel	0.039 (0.99)

Materials

Barrel	Brass, gold plated
Spring	Stainless steel
Ball	Stainless steel
Plunger	Beryllium copper, gold plated
Post	Nickel silver, gold plated

500641 Probe



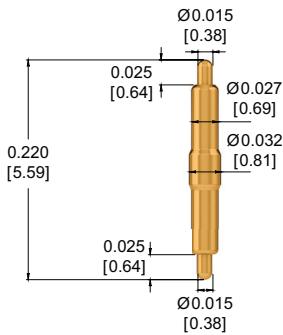
Probe Specifications

Part Number	500641-000
Minimum Centers	0.050 (1.27)
Current Rating	5 A continuous (individual probe in free air at ambient temperature)
Spring Force	1.7 oz (48 g) @ 0.030 (0.76) travel
Typical Resistance	< 50 mΩ
Maximum Travel	0.040 (1.02)
Working Travel	0.030 (0.76)

Materials

Barrel	Beryllium copper, gold plated
Spring	Stainless steel, gold plated
Plunger	Beryllium copper, gold plated

500389 Probe



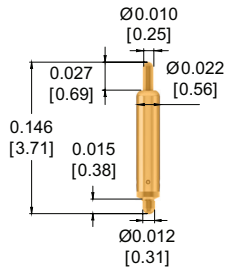
Probe Specifications

Part Number	500389-000
Minimum Centers	0.039 (0.99)
Current Rating	5 A continuous (individual probe in free air at ambient temperature)
Spring Force	3.0 oz (85 g) @ 0.040 (1.02) travel
Typical Resistance	30 mΩ
Maximum Travel	0.040 (1.02)
Working Travel	0.040 (1.02)

Materials

Barrel	Nickel silver, gold plated
Spring	Stainless steel, gold plated
Plunger	Beryllium copper, gold plated

102197 Probe



Probe Specifications

Part Number	102197-000
Minimum Centers	0.040 (1.02)
Current Rating	6 A continuous (individual probe in free air at ambient temperature)
Spring Force	1.4 oz (40 g) @ 0.014 (0.36) travel
Typical Resistance	< 75 m Ω
Maximum Travel	0.020 (0.51)
Working Travel	0.014 (0.36)

Materials

Barrel	Nickel silver, gold plated
Spring	Stainless steel, gold plated
Plunger & Post	Beryllium copper, gold plated

Performance Results

Spring Probe Part Number 102197-000

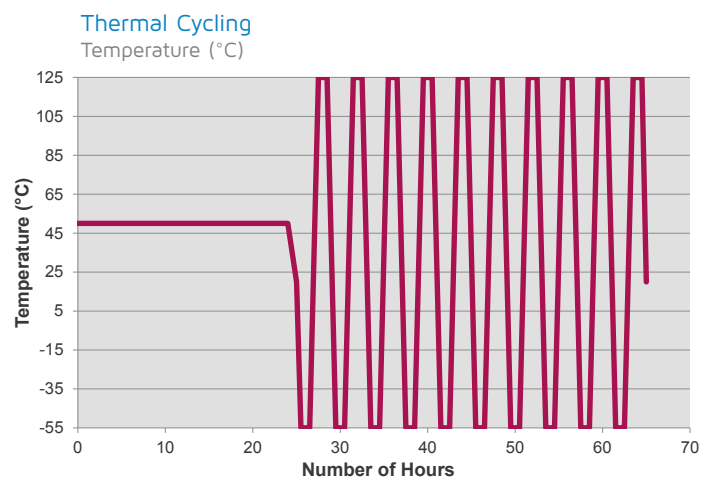
The following performance results are reflective of spring probe part number 102197-000 housed in a 128-pin interposer. The tests were conducted with the bottom side of the interposer mounted against PCB pads plated with 50 μm of gold. The interposer's top side was cycled against a gold over copper plate with the 4-wire resistance measured per EIA-364-23. The interposer's bottom side was preloaded while the top side was stroked flush with the Ultem 2300 housing. The thermal cycling, shock and vibration occurred consecutively on the same interposer.

Other spring probe designs will demonstrate similar performance with differences attributable to variations in diameter, overall length and spring force. For any questions please contact Smiths Interconnect.

Thermal Cycling

During thermal cycling, the interposer is in a static condition. The ambient temperature is 50°C and the interposer is allowed to soak for 24 hours. The temperature is then cycled between -55°C and 125°C with a 3-5 minute ramp rate, dwelling at each extreme for 1 hour. The contact resistance is monitored every 10 minutes.

- No electrical discontinuities
- Typical resistance: < 30 m Ω
- No contact resistance > 50 m Ω (3 Σ)



Vibration

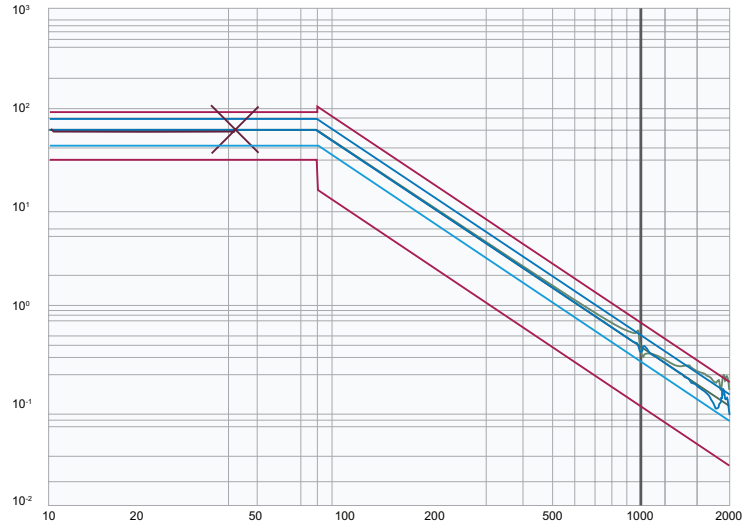
Testing was performed against Sinusoidal Vibration per EIA-364-28D, Test Condition IV, 20G peak level. The interposer was mounted between two PCBs which daisy chain the spring probe in series. Electrical continuity is monitored during vibration for any discontinuity greater than 1 μ s under an electrical load condition of 100 mAmps maximum using a DM600-10 monitor.

The sweep rate is 10 Hz to 2000 Hz at a rate of 20 minutes up and back. The sweep is repeated a total of 12 times per axis in 3 perpendicular axes for an exposure of 4 hours per axis and a total exposure of 12 hours.

- 10 Hz to 2000 Hz, 20G, 20 minutes, 12x each axis, X Y & Z
- No discontinuities > 1 μ s detected
- No physical damage observed

Initial Cycle 20G Sine Sweep X Axis

Displacement vs. Frequency



Segment	Frequency	Displacement	Acceleration	Velocity
1	10.00 Hz	60.000 mil pp	0.307 g pk	1.885 in/s pk
2	80.00 Hz	60.000 mil pp	19.632 g pk	15.080 in/s pk
3	2000.00 Hz	0.100 mil pp	20.450 g pk	0.628 in/s pk

Shock

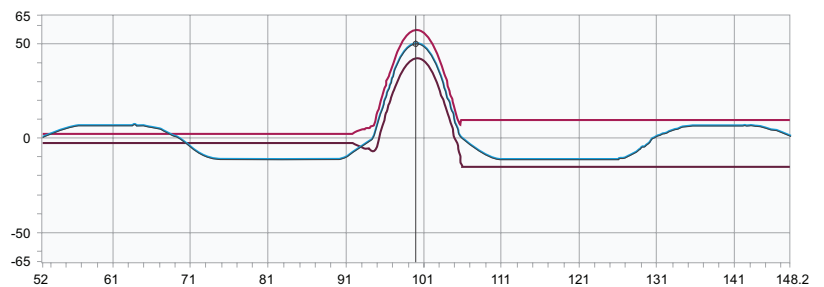
After vibration testing, the same interposer was subjected to 3 half sine shocks of 50 G with a duration of 11 ms in each axis for a total of 9 shocks. The amplitude tolerance was $\pm 15\%$.

The electrical continuity is monitored during shock for any discontinuity greater than 1 μ s under an electrical load condition of 100 mAmps maximum using a DM600-10 monitor.

- Sine shock 50G, 11 ms, 3 shocks in each axis, 18 total shocks
- No discontinuities > 1 μ s detected
- No physical damage observed

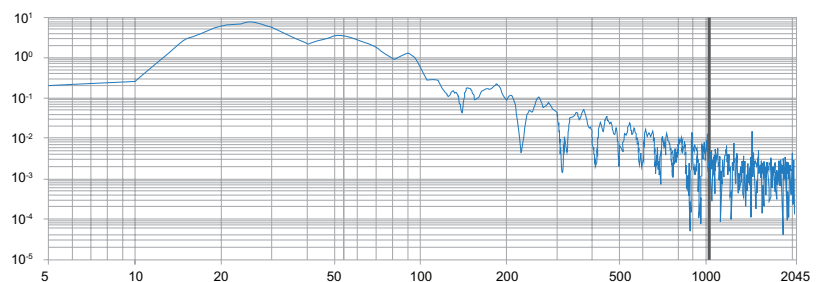
50G Shock X Axis

Acceleration vs. Time



X Axis Positive Shock

Amplitude vs. Frequency



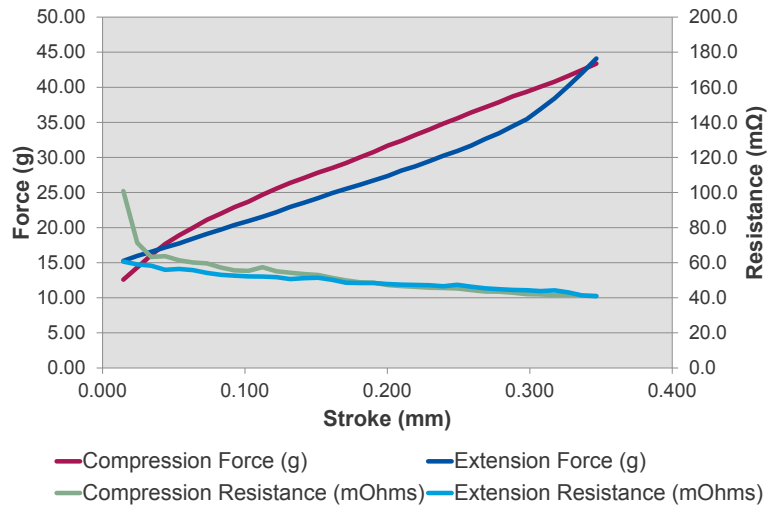
Force Deflection Resistance

The purpose of the Dynamic Force Deflection Resistance (FDR) test is to characterize the relationship between force and resistance as the spring probe is compressed and released dynamically. Typically, force and resistance have an inverse relationship where the contact resistance decreases as the force increases.

The resistance is measured between two gold plated contacts using the 4-wire test method. The force gage is mounted to a servo-driven linear stage. Both force and resistance are measured dynamically as the probe is compressed and returned illustrating resistance is stable throughout the stroke.

Dynamic Force Deflection Resistance

Average Force & Resistance vs. Stroke



Current Carrying Capacity

Current carrying capacity is characterized in a chamber designed to IEC 512-3 standards which protects the probe from air currents in all directions. Two J-type probe thermocouples are placed on the probe at approximately mid-point and the temperature is recorded. A third thermocouple measures the ambient temperature inside the chamber.

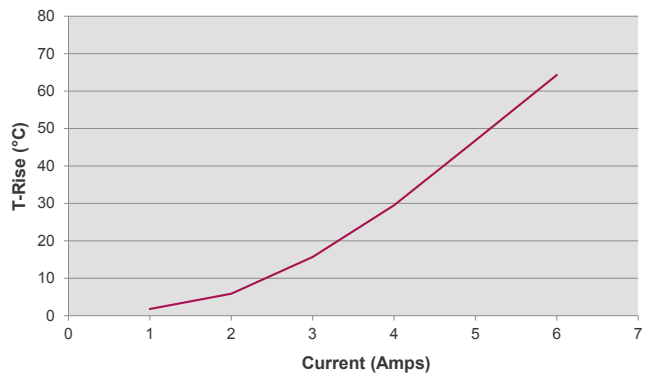
The current is increased by 1 Amp every 5 minutes until the probe reaches 80°C. The temperature rise is calculated (Probe Temp - Ambient Temp = T-Rise) and the curve is plotted. The current capacity is defined as the highest current before the probe reaches 80°C T-Rise.

- Less than 80°C temperature rise at 6 Amps

Current Capacity Test

Single Pin in Free Air

Max T-Rise (°C) vs. Current (A)



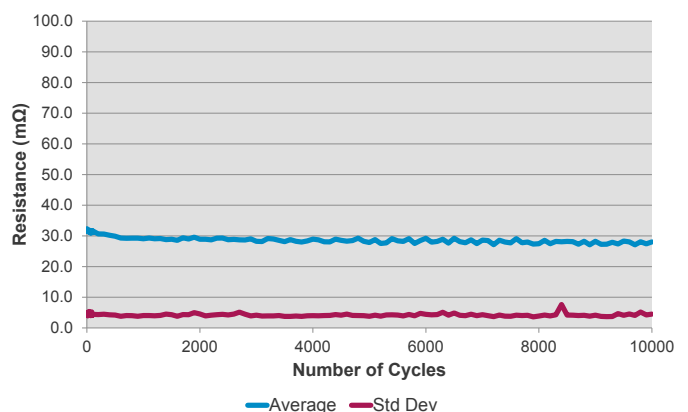
Life Cycle Test

The probe's cycle life is determined by complete mating and demating cycles measured on a custom life cycle tester. The interposer is mounted on a PCB and the top side is stroked for 10,000 cycles. The contact resistance is measured at prescribed intervals per EIA-364-23.

- Average: 30 mΩ
- Average + Standard Deviation: 40 mΩ
- 99.70% of measurements: < 50 mΩ

Mating Cycles (10K)

Average Resistance & Standard Deviation vs. Number of Cycles

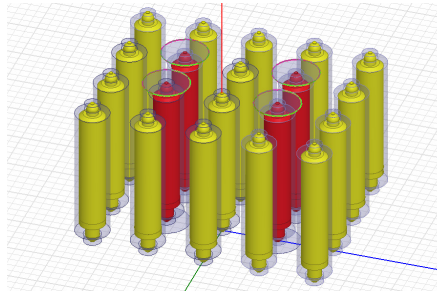


RF Differential

Differential RF performance was determined through simulation and optimization with HFSS software. The array shown (right) was utilized to determine the performance for this case. Probe arrays can be arranged in different configurations to achieve the desired performance.

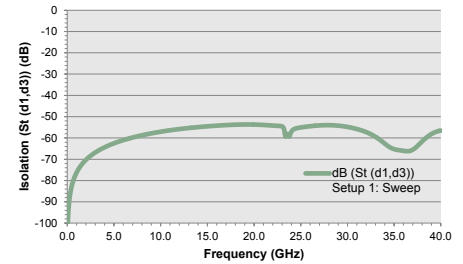
- Insertion Loss (-1 dB): > 40 GHz
- Return Loss (-20 dB): > 30 GHz
- Near-End Cross Talk: > 50 dB
- Impedance: 102 Ω

RF Differential Model
0.050" (1.27 mm) Pitch



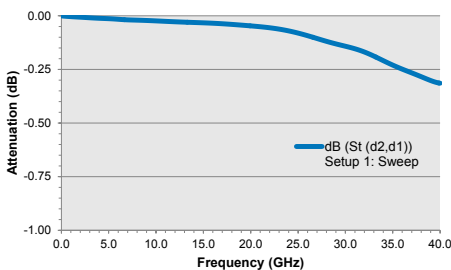
Near-End Crosstalk

Isolation (St(d1,d3))(dB) vs. Frequency (GHz)



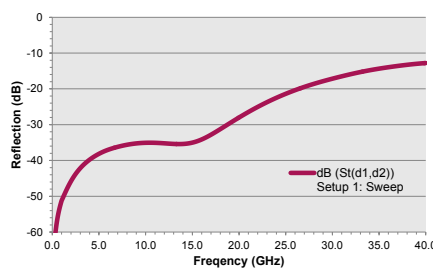
Insertion Loss

Attenuation (dB) vs. Frequency (GHz)



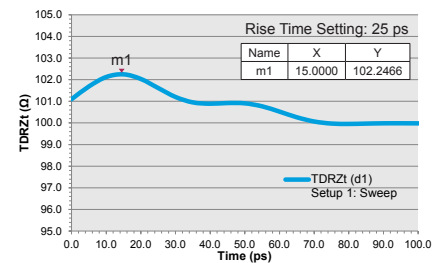
Return Loss

Reflection (dB) vs. Frequency (GHz)



TDR

TDR Zt (Ω) vs. Time (ns)

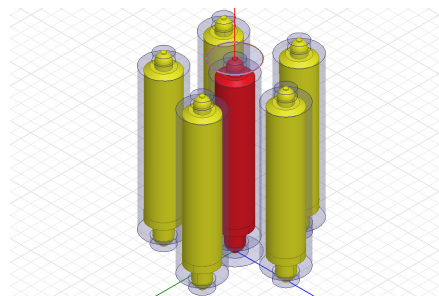


RF Single-Ended

Single-ended RF performance was determined through simulation and optimization using HFSS for the array shown (right). A circular array was used to demonstrate performance and capability. The pitch and arrangement can be optimized for any layout as required.

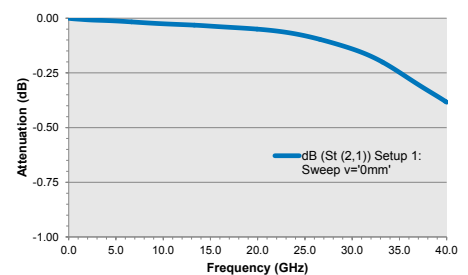
- Insertion Loss (-1 dB): > 40 GHz
- Return Loss (-20 dB): > 25 GHz
- Impedance: ~52 Ω

RF Single-Ended Coax Model
0.039" (0.99 mm) Radial



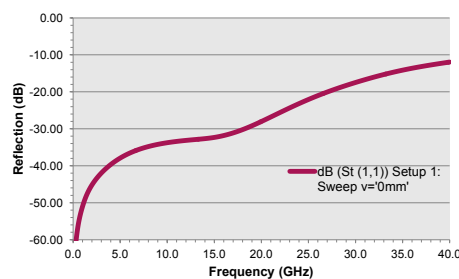
Insertion Loss

Attenuation (dB) vs. Frequency (GHz)



Return Loss

Reflection (dB) vs. Frequency (GHz)



TDR

TDR Zt (Ω) vs. Time (ns)

