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.
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.
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

Dimensions are in inches (mm) | All specifications are subject to change without notice
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 (polyphenolene 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

<table>
<thead>
<tr>
<th>Part Numbers</th>
<th>500033-000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Centers</td>
<td>0.039 (0.99)</td>
</tr>
<tr>
<td>Current Rating</td>
<td>3 A continuous</td>
</tr>
<tr>
<td>Spring Force</td>
<td>1.9 oz (54 g) @ 0.080 (2.03) travel</td>
</tr>
<tr>
<td>Typical Resistance</td>
<td>$&lt; 30$ mΩ</td>
</tr>
<tr>
<td>Maximum Travel</td>
<td>0.104 (2.64)</td>
</tr>
<tr>
<td>Working Travel</td>
<td>0.080 (2.03)</td>
</tr>
</tbody>
</table>

**Materials**

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

### 101367 Probe

<table>
<thead>
<tr>
<th>Part Numbers</th>
<th>101367-001 (OAL: 0.436&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Centers</td>
<td>0.039 (0.99)</td>
</tr>
<tr>
<td>Current Rating</td>
<td>5 A continuous</td>
</tr>
<tr>
<td>Spring Force</td>
<td>3.7 oz (105 g) @ 0.030 (0.76) travel</td>
</tr>
<tr>
<td>Typical Resistance</td>
<td>$&lt; 25$ mΩ</td>
</tr>
<tr>
<td>Maximum Travel</td>
<td>0.057 (1.45)</td>
</tr>
<tr>
<td>Working Travel</td>
<td>0.030 (0.76)</td>
</tr>
</tbody>
</table>

**Materials**

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

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Dimensions are in inches (mm) | All specifications are subject to change without notice

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6
Spring Probe Interposers

500057 Probe

Probe Specifications

<table>
<thead>
<tr>
<th>Part Number</th>
<th>500057-000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Centers</td>
<td>0.039 (0.99)</td>
</tr>
<tr>
<td>Current Rating</td>
<td>3 A continuous</td>
</tr>
<tr>
<td>(individual probe in free air at ambient temperature)</td>
<td></td>
</tr>
<tr>
<td>Spring Force</td>
<td>3.5 oz (99 g) @ 0.050 (1.27) travel</td>
</tr>
<tr>
<td>Typical Resistance</td>
<td>&lt; 10 mΩ</td>
</tr>
<tr>
<td>Maximum Travel</td>
<td>0.050 (1.27)</td>
</tr>
<tr>
<td>Working Travel</td>
<td>0.050 (1.27)</td>
</tr>
</tbody>
</table>

Materials

<table>
<thead>
<tr>
<th>Barrel</th>
<th>Nickel silver, gold plated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>Stainless steel, gold plated</td>
</tr>
<tr>
<td>Plunger</td>
<td>Beryllium copper, gold plated</td>
</tr>
</tbody>
</table>

500781 Probe

Probe Specifications

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

Materials

<table>
<thead>
<tr>
<th>Barrel</th>
<th>Brass, gold plated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Ball</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Plunger</td>
<td>Beryllium copper, gold plated</td>
</tr>
<tr>
<td>Post</td>
<td>Nickel silver, gold plated</td>
</tr>
</tbody>
</table>
### 500641 Probe

#### Probe Specifications

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

#### Materials

- **Barrel**: Beryllium copper, gold plated
- **Spring**: Stainless steel, gold plated
- **Plunger**: Beryllium copper, gold plated

#### Dimensions

<table>
<thead>
<tr>
<th>Ø0.017 [0.43]</th>
<th>0.030 [0.76]</th>
<th>Ø0.036 [0.91]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.300 [7.62]</td>
<td>0.060 [1.52]</td>
<td></td>
</tr>
</tbody>
</table>

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### 500389 Probe

#### Probe Specifications

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

#### Materials

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

#### Dimensions

<table>
<thead>
<tr>
<th>Ø0.015 [0.38]</th>
<th>0.025 [0.64]</th>
<th>Ø0.027 [0.69]</th>
<th>Ø0.032 [0.81]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.220 [5.59]</td>
<td>0.025 [0.64]</td>
<td>Ø0.003 [0.08]</td>
<td>0.025 [0.64]</td>
</tr>
</tbody>
</table>

Dimensions are in inches (mm) | All specifications are subject to change without notice
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 µin 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 mΩ
- No contact resistance > 50 mΩ (3 Σ)

Dimensions are in inches (mm) | All specifications are subject to change without notice
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 µs under an electrical load condition of 100 mAmperes 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 µs detected
- No physical damage observed

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 ±15%.

The electrical continuity is monitored during shock for any discontinuity greater than 1 µs 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 µs detected
- No physical damage observed
**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 platted 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](image)

**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](image)

**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)](image)
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 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

Dimensions are in inches (mm) | All specifications are subject to change without notice

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