SIGNAL INTEGRITY INC
SII Socket Handbook

This Document is Intended to act as a Specification, Application note and Maintenance Manual for the SII Test Socket Family from Signal Integrity Inc.

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SII Socket Handbook

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SII socket designs use Signal Integrity Spring Probes. Signal Integrity has been designing custom spring pin contacts for OEM semiconductor companies and socket/ contactor manufactures for over 20 years. Over this time SII has developed a vast catalog of spring contact configurations to best fit specific test and interconnect application requirements. Summarizing the Signal Integrity Contact technology:

Probe Device Plunger Material	• Proprietary Solid Pd Alloy • NiAu Plated Tool Hardened Steel • PdCo • PdAu plated BeCU
PCB Interface Plunger material	• NiAu plated BeCu • PdCo
Barrel Material	• Proprietary 3-layer Clad Construction • Au plated Brass • Au plated BeCu
Spring	• Stainless Steel • Music Wire Steel • Copper (non-magnetic)
Plunger to Barrel Contact Force Gain Function	• Bias Angle • Ball-Bias • double helix spring
Skin Effect Depth	Au Tight Grain Smooth Surface to 50μ depth (1MHz)
Impedance	Tuned Diameter to 50Ω ±5Ω

The following table is a snapshot of the contact probe and socket performance available in the Signal Integrity socket product line up.

SII Socket Performance Range

Socket Operation Specification	0.3mm Pitch	0.4mm Pitch	0.5mm Pitch	0.8mm Pitch	1.0mm Pitch
Minimum Operating Length	1.91mm	1.81mm	1.81mm	1.80mm	1.80mm
Maximum Operating Length	5.05mm	6.15mm	6.99mm	7.5mm	7.55mm
Maximum Contact Range	0.42mm	0.7mm	0.7mm	0.90mm	0.90mm
Nominal Contact Resistance	65 mΩ	60 mΩ	50 mΩ	20 mΩ	20 mΩ
Self Inductance[1] Min Max	 0.50nH 1.54nH	 0.37nH 0.78nH	 0.37nH 0.97nH	 0.48nH 0.63nH	 0.48nH 0.63nH
Capacitance[2] Min Max	 0.14pF 0.29pF	 0.29pF 0.36pF	 0.20pF 0.58pF	 0.38pF 0.88pF	 0.23pF 0.88pF

Mutual Inductance Min Max	 0.176nH 0.192nH	 0.127nH 0.208nH	 0.127nH 0.250nH	 0.09nH 0.304nH	 0.09nH 0.304nH
Mutual Capacitance Min Max	 0.096pF	 0.096pF 0.11pF	 0.096pF 0.22pF	 0.042pF 0.067pF	 0.042pF 0.067pF
Insertion Loss[3] (-1dB) Min Max	 32GHz 50GHz	 16GHz 60GHz	 12GHz 60 GHz	 8GHz 60 GHz	 8GHz 60GHz
Return Loss[4] (–20dB) Impedance Matching Range	8-15 GHz	8-17GHz	6-19GHz	6-30GHz	8-22 GHz
CrossTalk[5] (-20dB) Far End Near End	 43GHz 7.4GHz	 58GHz 13.4GHz	 43GHz 11.8GHz	 33GHz 11.8GHz	 >50GHz 12GHz
Maximum Continuous Current[6]	1.43A	4.3A	4.3A	6.0A	7.0A
Maximum Pulsed Current[7]	2.04A	6.5A	5.17A	11A	16A
Pin to Pin Leakage[8]	<1pa@100V				
Socket Operation Specification	0.3mm Pitch	0.4mm Pitch	0.5mm Pitch	0.8mm Pitch	1.0mm Pitch
Spring Force at operating length Min Max	 10gr 20gr	 11gr 40gr	 11gr 53gr	 17gr 44gr	 17gr 45gr
Contactor Life Plunger[9]	>300,000	>300,000	>400,000	>500,000	>500,000
Contact Length Variance	+/- 0.03mm				
PCB Via to Device Pin Offset	0.00mm				
Package Coplanarity Frequency <15GHz Up to 50 GHz	 +/- 0.21mm +/- 0.10mm	 +/- 0.25mm +/- 0.07mm	 +/- 0.30mm +/- 0.10mm	 +/- 0.55mm +/- 0.11mm	 +/- 0.55mm +/- 0.11mm
Contact Length Variance	+/- 0.03mm				

Socket Housing Materials[10]	Semitron™ MDS100 Torlon™ 5030 Vespel™ SP1	Torlon5030™ Vespel™ SP1 Semitron™ MDS100	Torlon5030™ Vespel™ SP1 Semitron™ MDS100	Torlon5030™ Vespel™ SP1 Semitron™ MDS100	Torlon5030™ Vespel SP1™ Semitron™ MDS100
Contactor Plunger Material	Solid Precious Metal Pd Alloy Device Interface Plunger BeCu/Gold Plated PCB Interface Plunger				
Contactor Barrel Material[11]	Proprietary Precious Metal/BeCu Alloy Clad Construction			Proprietary Clad Au Plated	Proprietary Clad Au Plated
Contactor Spring Material	Gold Plated Stainless Steel Gold Plated Music Wire				
Temperature Range	Stainless Steel Spring -120°to +260°C Music Wire Spring -40° to +125°C Cryogenic operation[12] at 4°K <= 10000 insertions (Thermal cycling)				
Socket Housing Lifetime	>2,500,000 Insertions for three-piece contactor >2,000,000 Insertions for two-piece contactor				

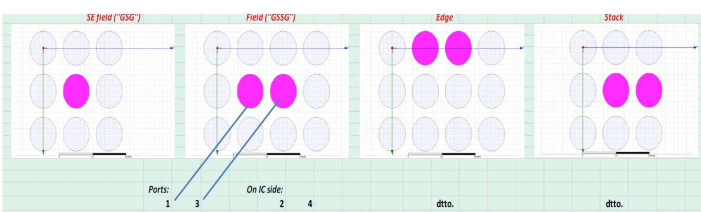
Notes:

[1] Self Inductance valid to 14 GHz for spice modeling. See SII applications engineering for Modeling up to 70GHz for specific package configurations and PCB trace to socket launches.

[2] Capacitance referenced to Gnd. Capacitance valid to 14 GHz for Spice modeling. For power integrity modeling see SI applications engineering for specific contactor low frequency capacitance values.

[3,4,5] Insertion loss validated on Keysight 8722 ES VNA. Modeled to 95GHz on Ansys HFSS.

S Parameters are dependent on measured pin configuration. Signal Integrity uses a suite of configurations to derive S-parameters. These are the test and modeling configurations used for these specifications:



[4] Return Loss indicates how much energy is reflected to the source. It is a measure of how well the socket signal-GND transmission line impedance matches 50/100 ohms. The diameter of the probe and the pitch and location of the return pins determine the channel impedance of the socket. Balancing return loss can allow the designer to use a longer pin length with better S-Parameters than a short pin with a poor impedance match.

[6] Maximum Continuous current is defined as the point at which the temperature of the probe rises 25°C.

[7] Pulsed current is measured with a 10% Duty Cycle. On time is 300msec.

[8] Volume resistivity for Torlon™ 5030 is 10^{18}. Minimum pin to pin separation is 0.08mm for 0.3mm Kelvin connections.

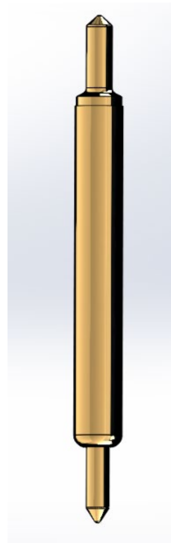
[9] Plunger life is based on the wear rate to reduce the contact pressure 50%. Plunger contact wear assumes tin matte or solder ball device contact and a cleaning pad cycle every 15,000 insertions. Contact pressure is balanced by spring force and initial contact area of the contact probe selected for the individual socket design.

[10] Sockets designed for power or DC applications typically are designed in Torlon 5030 for low leakage and high temperature performance. High frequency Sockets (>5GHz) are typically designed in Vespel SP1 for low dielectric and high strength. Semitron MDS 100 (PEEK) is used for very fine pitch construction to maintain the drill registration and pin to pin wall strength. Very large arrays use this as well for strength across the array to prevent bowing in the drill hole array.
Clad metal barrels are used to maintain very consistent inner wall conducting surfaces vs plating consistency on very small diameter barrels.

Specifications provided here are based on internal testing at Signal Integrity, customer production sites, and third-party electrical testing. Actual individual results may vary based on a wide range of variables including handler/contactor/load board interface, handler plunge depth and velocity, device presentation, alignment plate condition, package plating characteristics, test floor conditions, maintenance activities, mounting/fastening techniques, non-coplanarity from site to site, non-coplanar docking, temperature, and current extremes. Over driving contactor current specifications can reduce the life of the contactor due to thermal effects

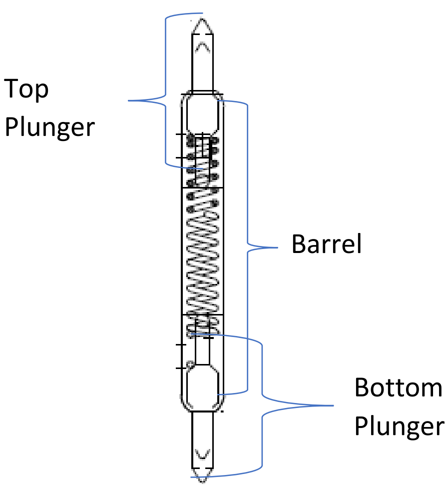
Spring Probe Description

Three Piece Probe

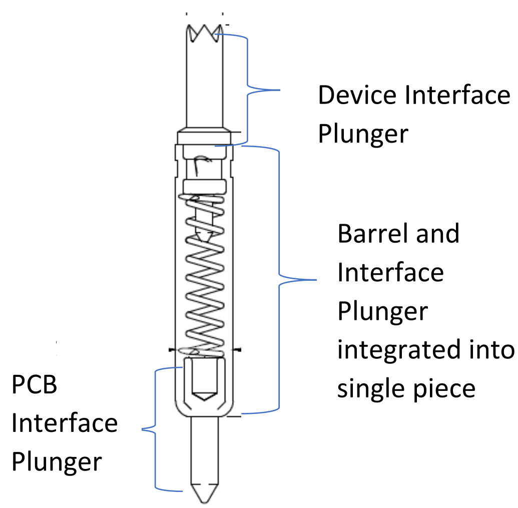


Two Piece Probe

A three-piece probe consists of two contact plungers and a spring inside a barrel assembly. With a three-piece probe, the barrel remains fixed in the socket cavity and the plungers on the device interface and PCB side move with the spring compression. A two-piece probe integrates the device plunger and barrel and compresses a spring onto the board plunger. The integrated barrel plunger slides within the cavity.



Three Piece Probe



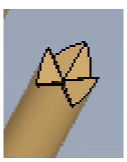
Two Piece Probe

For the three-piece probe, the socket fixture compresses the bottom plunger on the PCB with a preload force. The top plunger is compressed by the additional force that is applied to the device as it is pressed down into the socket cavity. For a two-piece probe, the spring is fixed under a small load (~10gr) when the pin is assembled. When the device is inserted into the socket it compresses the barrel-device interface plunger assembly. The device interface assembly moves up and down in the socket cavity with the PCB interface plunger remains fixed.

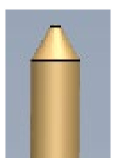
The compressed spring generates the force that creates the pressure needed to break the surface asperities and oxide layers on the device contact, PCB board contact and internal barrel/plunger surface. A low contact resistance is established by the force of the spring against the small surface area of the contact surfaces.

Probe Components

Device Interface Plunger Contact Tip Designs



4-point crown



Conic

Ogive

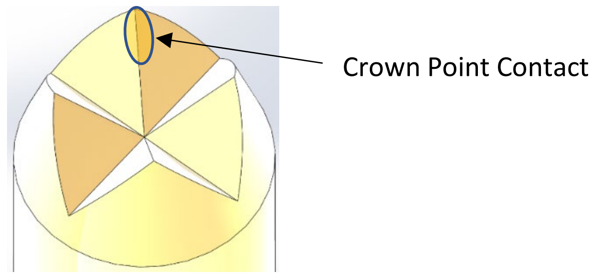
Reduced 4-point crown

Smooth Spherical

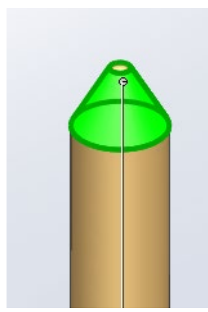
Contact Design Surface Area

Probe Geometry					
Pitch	0.3mm	0.4mm	0.5mm	0.8mm	1.0mm
	Contact Surface Area				
4-pt Crown[1]	$0.003mm^2$	$0.003mm^2$	$0.006mm^2$	$0.019mm^2$	$0.029mm^2$
Conic[2]	NA	$0.006mm^2$	$0.02mm^2$	$.03mm^2$	$0.044mm^2$
Ogive[3]	$0.0015mm^2$	$0.0025mm^2$	$0.0045mm^2$	$0.06mm^2$	NA
Reduced 4-pt Crown[4]	NA	NA	$0.004mm^2$	$0.012mm^2$	$0.020mm^2$
Smooth Spherical[5]	$0.003mm^2$	$0.004mm^2$	$0.007mm^2$	$0.01mm^2$	$.015mm^2$

Note [1]: 4-point crown surface area is calculated as 4 times the sum of the area of the two triangular contact points on the solder balls along the radial center edge of the crown. We assume 1/3rd of the crown radius contacts the solder ball. At 0.3mm pitch we assume 1/2 of the edge of the crown is the contact point on the solder ball.

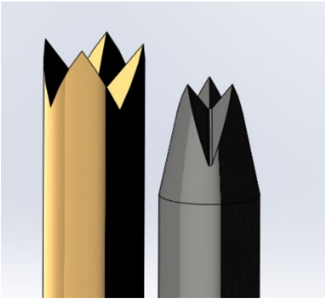


Note [2]: Conic Tip Surface area calculation uses 10% of the total surface area of the cone as the working contact surface area on a device pad.

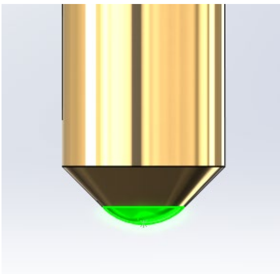


Note [3] Ogive assumes 10% of surface area is in contact with device pad.

Note [4] Reduced crown vs Full Crown - Less surface area than 4-point crown. Steeper attack angle on contact target as well.



[5] Smooth Spherical Radius



Applications for Each Tip Style

4-Point Crown

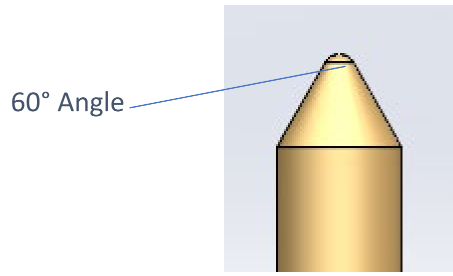
A 4-point Crown is used for contacting solder balls on a Ball Grid Array. Making contact on solder balls is challenging. The probe must adapt to an uneven surface on the solder ball spheroid. The probe pressure on the solder ball cannot be so high as to damage the softer solder material so a device would fail visual inspection. The probe tip pressure must be high enough to break the oxide layer on the solder ball. The crown geometry must be able to slough off the debris created when contacting the solder ball.

Reduced 4-Point Crown

A reduced 4-point crown will provide a smaller contact witness mark on the balls, and additional contact pressure on the solder ball. For BGA arrays with a pitch of at least 0.5mm, a reduced crown is a good choice for solder balls at 0.3mm diameter. Reduced crown tips are also excellent at contacting metal lead frames on packages like TSSOP, SSOPs and SOPs.

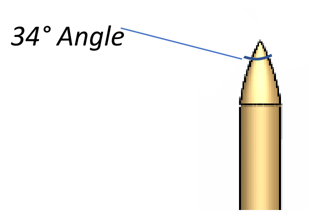
Conic

A conic tip is a common design for making contact on a device with pads. The conic tip can be used on NiAu, NiPdAu and Tin Matte pads. It applies pressure at the tip of the cone so it can break the oxide and contamination on a device pad. The tip should leave a single witness mark on a tin matte pad but a hard NiAu pad on a LGA device can be clear of any marks, leaving a smooth surface for a solder ball. The conic tip attack angles are nominally 60°



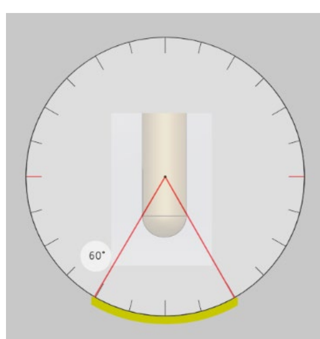
Ogive

An Ogive probe tip is shaped like a ballistic nose cone. It is the intersection of two arcs. The shape is strong and has a sharper force angle (17° tangent) on the contact point than the conic tip. This style of probe tip generates greater contact pressure vs. a conical tip. This type of probe tip is often used on fine pitch matte tin pads and leaded devices with larger variances in contact location per device. The sharper tip can break through pads with thicker oxide issues and the sharper angle can slough off contact debris easier.



Smooth Spherical

A smooth spherical tip has a radius curve to contact the surface of the DUT. This tip shape has a 60° radius for the contact surface. This type of tip will distribute the pressure more than a pointed tip and will be the least aggressive to the contact pads.



Smooth Spherical 60° Radius

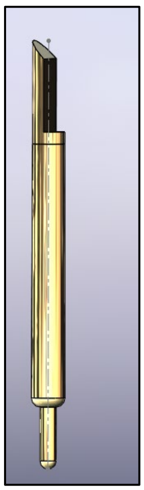
PCB Interface Plunger Contact Selection

Signal Integrity sockets can use any plunger tip style on the bottom side of the socket. A hard gold PCB pad is easier to keep clean and does not develop a significant insulative oxide layer. The smooth spherical is the preferred plunger tip style for the board side contact. This produces less contact pressure on the gold pad and prevents damage to the PCB board.

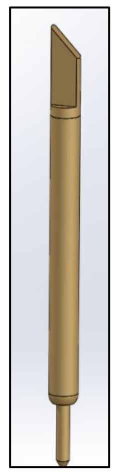
Kelvin Probe Tip Styles

For the test contact applications that require a Kelvin connection at the device pad, Signal Integrity offers special tip geometries to enable two plunger tips on a single pad.

Signal Integrity offers three types of Kelvin probe contact tips:

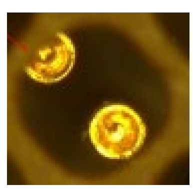


1) Angled half-circle



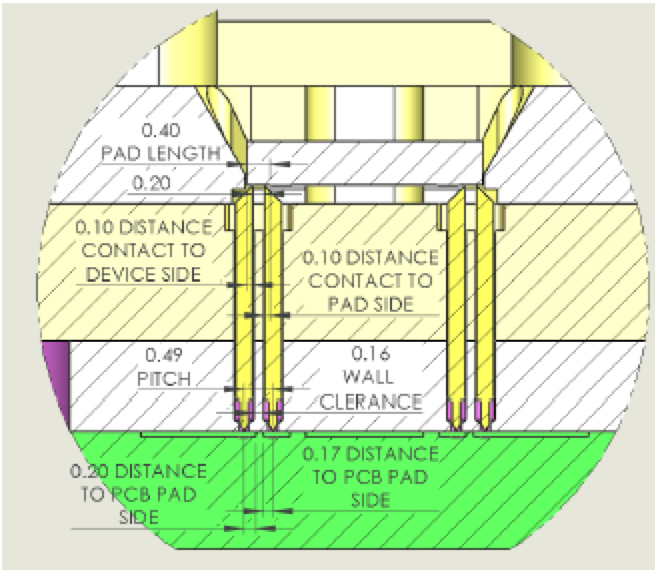
2) Flat Angle (Shark Fin)

3) Indented conic (Cup) style for BGA packages down to 0.3mm pitch.



0.3mm Kelvin Contact with BGA Cup Tips

The pin pair is positioned tangentially to the device pad on the long point side. This allows for the tight tip separation needed on a small pad.



0.1mm Contact Witness Marks

Flat Angle Kelvin Pair

Kelvin Contact Specifications

Tip Style	Minimum Tip to Tip separation	Minimum Wall Thickness
Flat Angle[1]	0.08mm	0.08mm[2]
Angled Half Circle	0.12mm	0.12mm
0.3mm 4-pt Crown[3]	0.28mm	0.03

Notes:

[1] Socket is keyed to maintain the tip position with a slotted plunger receptacle.

[2] This specification is for Semitron MDS100

[3] Standard model AA917-F6- 0.3mm BGA probe.

Springs and Contact Force

Signal Integrity designs custom springs to generate the force the probe needs to make contact between the PCB board and the test device. Each probe model can be adjusted for total contact force through the plungers. The spring design can be adjusted to control the biasing force of the plunger against the inner wall of the barrel. Our spring designs integrate the helix pitch, OD/ID and wire diameter characteristics to increase force, customize the force curve, lower bulk resistance, and increase current carrying capacity.

The probe springs are made of four materials:

- Music Wire – This is high carbon, high tensile steel material. The music wire spring is gold plated.
- Stainless Steel – Low carbon (302 or 304)) stainless steel. The stainless-steel spring are also gold plated.
- High temperature stainless steel - proprietary alloy, gold plated.
- Copper - non-magnetic, plated.

Music wire springs will produce more force than a stainless-steel spring of the same mechanical specification. Stainless steel springs have a wider thermal range, maintaining characteristics at a continuous operating temperature above 150°C while a music wire spring is rated to 125°C. Stainless steel springs are more durable with a longer operating life than music wire. Note that the life of both types of springs is well over 1,000,000 cycles. Copper springs are used for non-magnetic applications.

Stainless steel springs will also work also work at lower temperatures than music wire springs. Signal Integrity stainless steel springs are specified to operate at -65°C vs. -30°C for a music wire spring. Stainless steel springs are also used in cryogenic semi-static applications.

Spring Material	Temp. Range
Music Wire	-30° - 120°C
Stainless Steel	-65°- 180°C

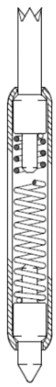
Spring Force Range[1]				
0.3mm	0.4mm	0.5mm	0.8mm	1.0mm
10-23 gr	8-35 gr	8-40 gr	12-45 gr	16-54 gr

[1] The spring force of the probes are published for the optimal compressed length of the spring. The limits can be adjusted for specific applications, and fixtured probe lengths

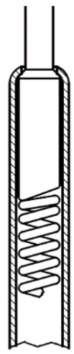
Spring to Plunger Interface Options

A standard single spring in a probe design, under compression, will buckle and force contact to the inner wall of the barrel with the bearing surface of the plunger.

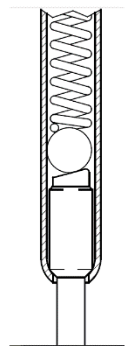
The SII probes used in SII socket designs include spring/plunger interface features that ensure consistent spring buckle under compression. A single spring without force control features, will buckle inconsistently as the force varies per part. It may bend and twist contacting the barrel at different locations per insertion. This causes variations in contact pressure on the barrel wall which affects the contact resistance consistency over the probe compliance range. Signal Integrity design features improves consistency, spring force and pressure which in turn helps the pin carry more current for a higher number of insertions.



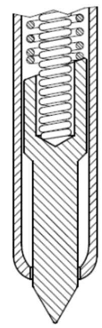
Standard 3-piece probe



Probe with Biased Plunger



Ball and bias plunger



Counter Helix Dual Spring

SII uses a bias angle plunger interface to the spring on many of its probe designs. This is a feature added to control the spring buckle and plunger deflection under compression. This angle on the plunger base forces the spring to bend consistently and maintain a very repeatable spring force over the life of the pin. This bias angle creates greater surface contact pressure on the plunger bearing surface to the clad surface on the inner wall of the barrel. This has the additional advantage of improving the DC current carrying capacity of the probe without any impact on the high frequency performance of the probe

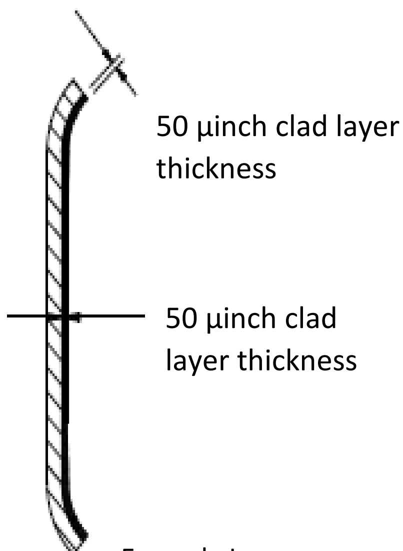
SII also designs probes that combine a ball with a precise bias angled plunger. Positioning a ball to interface between the spring and plunger provides a uniform contact surface and a larger contact area for the spring to the barrel wall. The arc radius under compression is kept constant under varying loads on the plunger keeping the resistance curve flat through the compliance range. This improves the DC current carrying capacity over the life of the pin as well.

The counter helix, multiple spring design incorporates at least two springs and a plunger with a biasing angle. This controls the buckle and spring force with even greater precision and this design allows for greater flexibility in the force-contact curve. The workload is split between the springs, The outer spring controls spring buckle and wall contact pressure and the inner spring controls the plunger contact force. We can achieve very consistent, high spring force with a low stress design on fine pitch diameter probes. The additional mass also allows the probe to carry more continuous current. The larger thermal mass of this probe allows it to carry much higher pulsed currents.

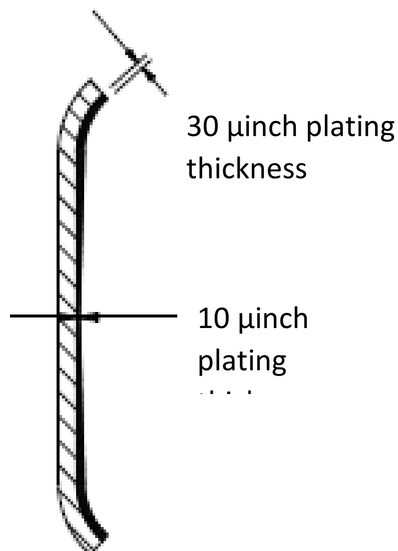
Clad Metal Strip Barrels

SII spring probes use barrels made with a proprietary clad strip stock. Clad material is a multilayer strip of metals worked under pressure to the proper thickness and punched into barrels. This is superior to using plated tubes, especially for fine pitch probes at 0.5mm or below. When a small diameter tube is plated, it is difficult to maintain consistent plating inside walls of the tube. Plating thickness on the OD of the tube is generally 80% greater than the ID of the tube. For fine diameter probes at 0.3mm pitch, a clad barrel inner wall has consistent thickness the length of the inner diameter. SII probes have a consistent 50uin thick proprietary precious metal alloy layer on the inner circumference of the barrel. The plunger movement will wear this hardened precious metal layer consistently and the probe will operate at lower contact resistance. The clad layer bears up to the spring compression wear much longer than the thin portions of the inner plating on a plated BeCU barrel.

The middle layer of the SII clad barrel is BeCu for conductivity and strength and the outside layer of the clad barrel is Au alloy. Since the outside layer is wrought it has a very low surface roughness for minimal skin effect loss at high frequencies.



Example Inner clad layer



Example Inner plating thickness

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Socket Body Material

Trade Name	Model Number	Material Source MFG
Torlon	5030	Solvay
Torlon	5530	Professional Plastics
Modified PEEK	MDS100	Semitron
Vespel	SP1	DuPont

Specification	Torlon™ 5030	Torlon™ 5530	Semitron™ MDS100	Vespel™ SP1
Flexural Strength	248 MPa	138 MPa	141 MPa	110MPa
Tensile Strength	172 MPa	103 MPa	82.7 MPa	86MPa
Hardness Rockwell	E90	E85	E121	E60
Coefficient of Friction	0.19	0.20	0.4	0.35
Continuous Operating temperature	260°C	260°C	249°C	260°C
Surface Resistivity	>10^{17} Ω	>$10^{13Ω}$	>$10^{13Ω}$	>$10^{13Ω}$
Dielectric Constant (dK)	4.3	6.2	3.37	3.55
Dissipation (dF)	0.05	0.22	0.007	0.003

Socket Body Material Features

Torlon™ 5030 is the primary material we use in high volume, commercial applications. It is very strong, wear resistant and has excellent thermal characteristics.

Torlon 5530 is easier to machine than 5030 and has very good strength and thermal characteristics.

Semitron MDS100 (PEEK) is used for very large arrays where the stiffer material prevents bowing with very short pin cavities. It has excellent high frequency properties. In addition, ceramic PEEK can hold very thin wall dimensions for Kelvin pin designs.

Vespel SP1 is primarily used for microwave and high frequency devices from small interconnect devices to very large arrays. It has a lower loss tangent for high frequency and is more mechanically flexible than MDS100 so it can be machined and drilled for very short pin lengths and maintain conformity to the PCB board.

Signal Integrity Socket Designs

The SII socket line can address any package type from 1x1mm bare die strip test to very large 5000 pin BGA arrays.

Example SII Socket Design for a Low Pin Count, High Volume Automotive and Commercial QFN Package

Background

Packages in this marketplace are usually small, fine pitch (0.5mm or less) and thin. The test insertion count for these devices is very high so the socket must be designed for low cost per insertion, extended probe lifetime, minimal socket maintenance, ease of probe replacement and probe cleaning. The socket frame and guide plates are precision machined to interface with pick and place handlers or high-speed, gravity feed, strip test or high-speed turret handlers. The probe electrical performance and mechanical performance is crucial for consistent high first pass contact yield.

The example device this socket solution addresses is a **5mmx5mmx0.75mm QFN at 0.5mm pad pitch**

This type of package is used in many high-volume smart power, IOT and automotive applications.

We will use a typical device for power delivery and power management that has integrated control logic and a sensor interface.

Test Challenges

- Deliver high continuous current (10 amps nominal)
- Deliver large pulsed current (50 amps nominal)
- Low current measurements, high resolution sensor inputs.
- Very low R_{on}
- Matte Tin Pads

SII Socket Components for this Application

- Probe – B2501-AF
- Guide Plate
- Socket Frame

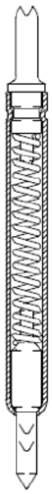
B2501-AF Design Guide

This probe is chosen for the 0.5mm pitch on the package pads, contact resistance and current carrying capacity. The probe plunger is a conic tip made of proprietary homogeneous Pd alloy. Solid Pd alloy is used on the tin matte pads and NiPdAu pads. A Pd alloy maintains low-contact resistance through the wear created by aggressive cleaning cycles since it is homogeneous and impervious to oxide build up since there is no sacrificial plating layer to wear away. The B2501-AF uses a stainless-steel spring to achieve the longest lifetime over the full -65^{o}C to 185^{o}C test temperature range.

B2501-AF Design Details	
Probe Design	Two-piece Integrated DUT plunger/Barrel
Operating Length	3.77mm
DUT Plunger Tip Style	Conic
PCB Plunger Tip Style	Smooth Spherical
Spring to Plunger Design	Single Spring non-biased plunger
Barrel Material	SII Clad
DUT Interface Plunger material	Homogenous hardened Pd alloy
DUT Plunger Hardness	475 to 510 Hv3
PCB Interface Plunger material	Hard Gold Plated BeCu
Barrel diameter	0.35mm
DUT Interface minimum pad diameter	0.10mm (0.5 x 0.19mm) for conic tip
PCB Side minimum pad diameter	0.17mm
Spring material	Gold Plated Stainless Steel
Temperature Range	-50°C to 150°C
Spring Force at 3.77mm length	31 grams at operating position (0.30N)
Force needed to contact plunger to barrel	3gr
Force used in preload PCB contact	9.5gr
Force available for device contact	19gr (0.19N)
Contact Resistance	50mΩ
Nominal Contact Surface Area	0.02mm
Contact Pressure on Device Pad	9.5MPa
Spring Rate	1.25gr/0.025mm
Spring /Plunger Interface	Single Spring-Non-Biasing Two Piece
Contact Range	+/- 0.22mm (OP is reference)
Continuous Current	2.3A
Pulsed Current	5.2A at 10% duty cycle (300ms cycle)
Capacitance (to GND) at OP	0.58pF
Series Inductance at OP	0.79nH
Mutual Coupling Capacitance at 0.5mm	0.1pF

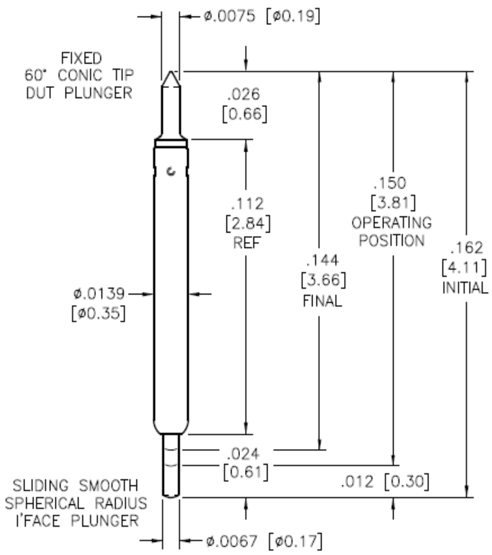
B2501-AF Probe Operation

The B2501-AF spring probe uses Signal Integrity's proprietary clad metal barrel construction. The consistent smooth inner wall material provides consistent plunger to barrel contact resistance and the long lifespan in a simple, robust sliding contact technology.

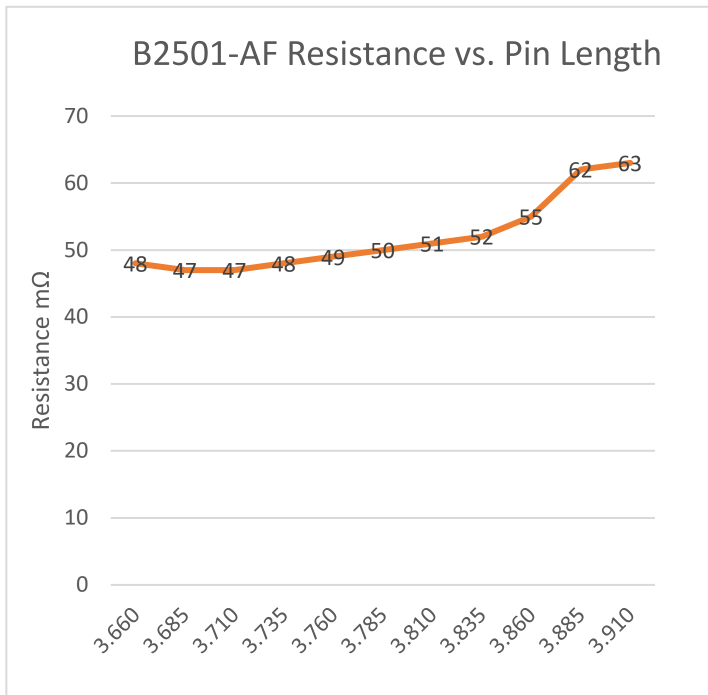


B2501-AF

- Conventional non-biasing construction.
- In non-biasing construction, the spring deformation at operating position forces the plunger against the inside of the barrel.
- The optimal current path is achieved from the DUT plunger, through the barrel, directly to the sliding plunger.
- At high current, the spring will also provide a path to relieve the current density and provide more thermal mass

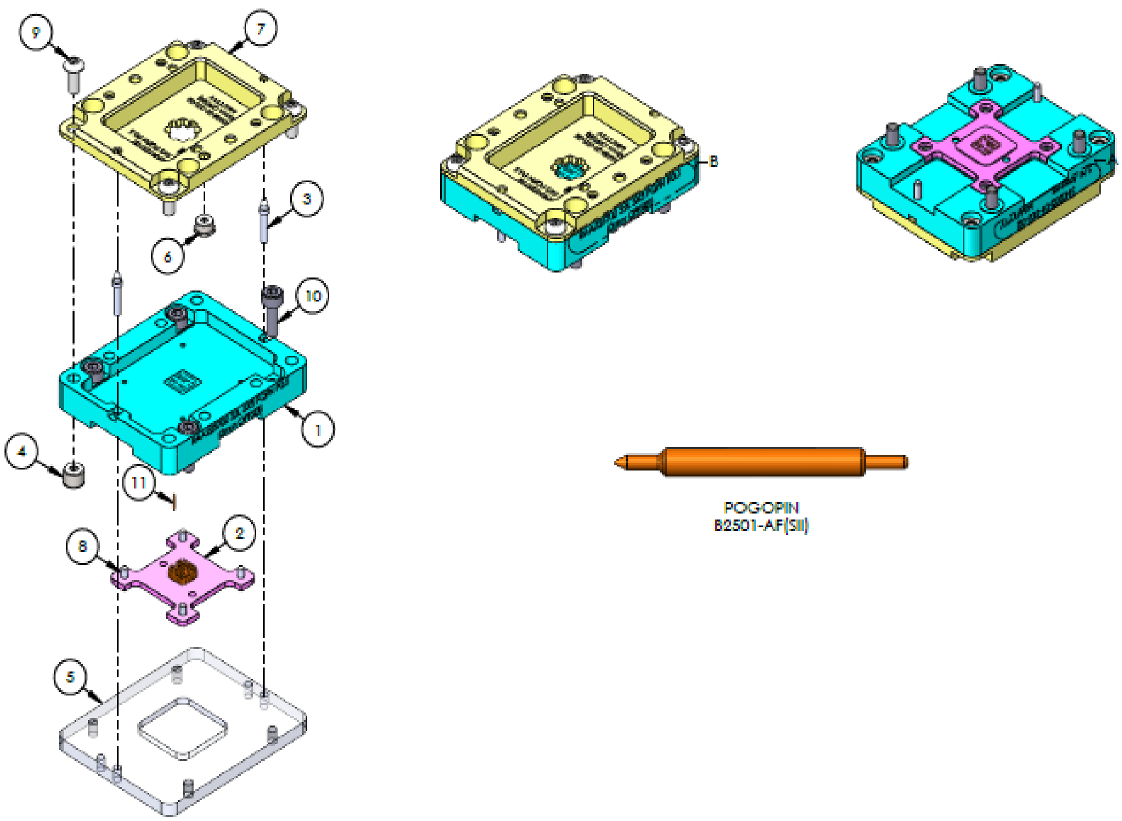


B2501 Dimension Drawing



SII Socket Components

Each SII socket design from Signal integrity comes with a set of dimensioned drawings, a 3D STEP file, bill of materials and PCB footprint file to aid in the PCB layout and component library. The example socket for a 32L PQFN package has 11 components in the bill of materials (BOM).



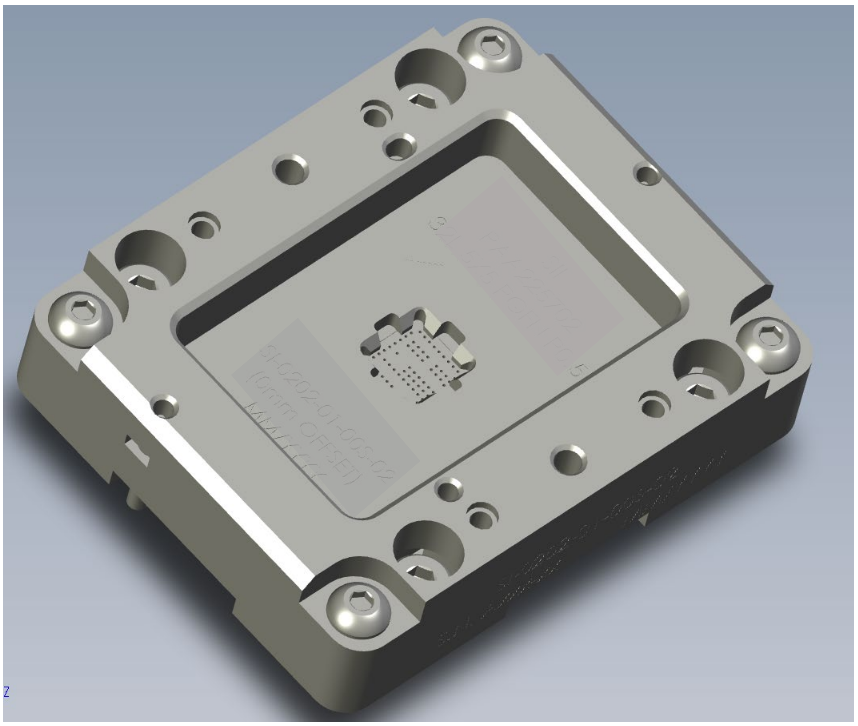
Item No.	Part No.	Material	Description	Qty.	Supplier
1	SI-xxxx-01-01P	Torlon 5030	Top Pin Plate -Frame Housing	1	SII
2	SI-xxxx-01-02P	Torlon 5030	Bottom Pin Plate	1	SII
3	SI-xxxx-01-03P	S/S	Guide Pin	2	SII
4	SI-xxxx-01-04P	S/S	M2.5 INSERT	4	SII
5	SI-xxxx-01-05P	Polycarbonate	Pin Protection Cover[2]	1	SII
6	SI-xxxx-01-06P	S/S	M2 INSERT	4	SII
7	SI-xxxx-01-07P	Torlon 5030	Guide Plate	1	SII
8	M1.4X0.3	Nylon	PHILLIP PAN HEAD M/C SCREW M1.4X0.3X2.5	4	Off-the-Shelf[1,3]
9	M2.5X0.45	S/S	BUTTON HEAD CAP SCREW M2.5X0.45XL6	4	Off-the-Shelf
10	M2.5X0.45	S/S	SOCKET HEAD CAP SCREW M2.5X0.45 X L8	4	Off-the-Shelf
11	B2501-AF		Spring Probe Pin	65	Off-the-Shelf

SII QFN Socket Parts List

[1] *SII uses Mil-spec components for off the shelf screws and fasteners. User can replace with local sourced parts for these components*.

[2] The pin cover is used for shipping and storing the SII socket. It must be removed to install the socket on the PCB board.

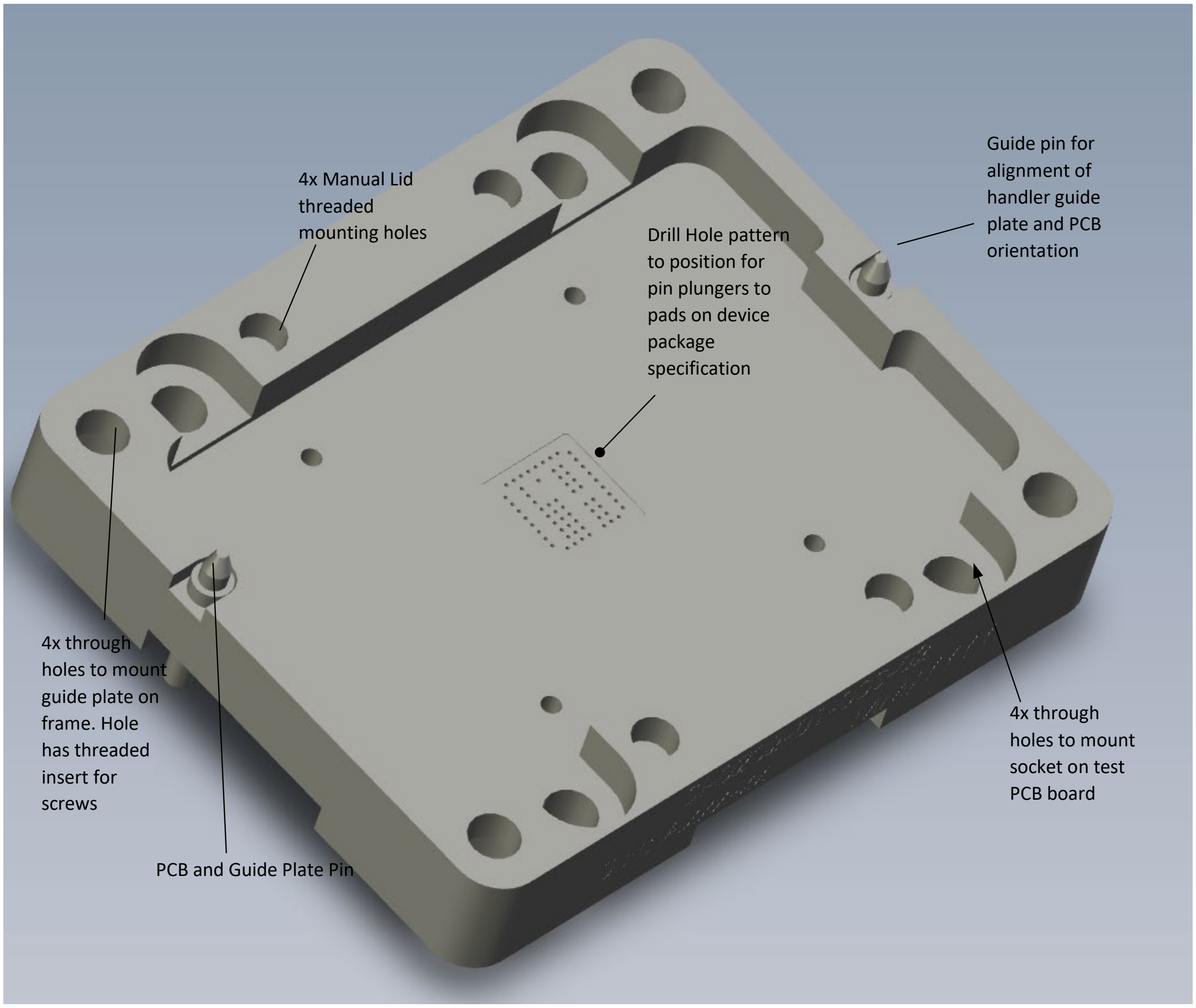
[3] Care should be taken to ensure the screw heads at the corners of the bottom plate (8) are slightly recessed and do not protrude below the bottom plane and interfere with the mounting of the socket.

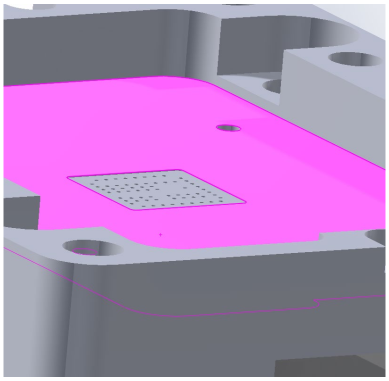


3D Socket Rendering

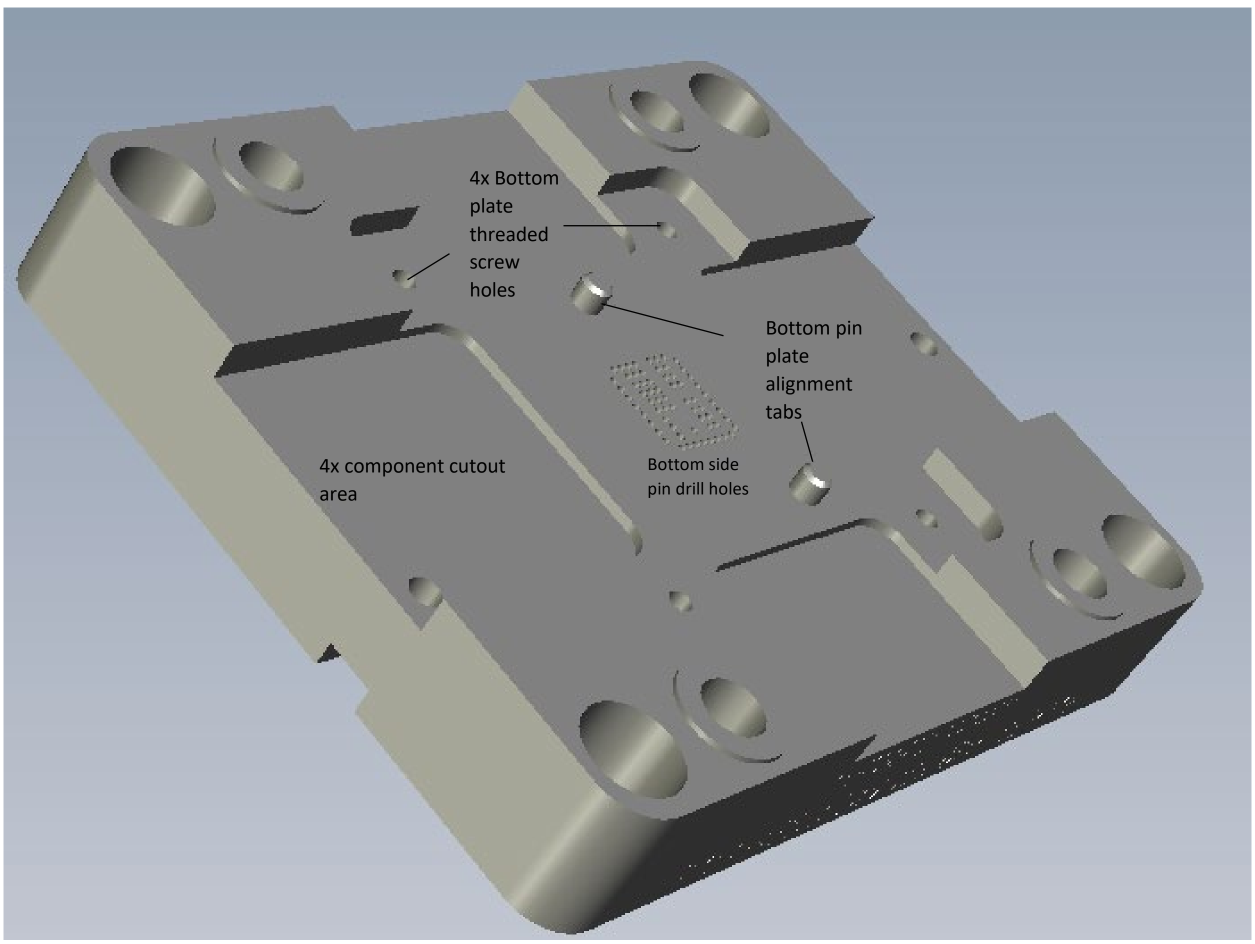
Top Pin Plate Description

In this socket design the top pin plate, outside frame and housing are integrated into a single machined component. This keeps the complexity and cost lower. The housing is manufactured from Torlon™ 5030 for strength and durability. This material is rugged, and glass reinforced for resistance to cracking or breaking under test cell operation.



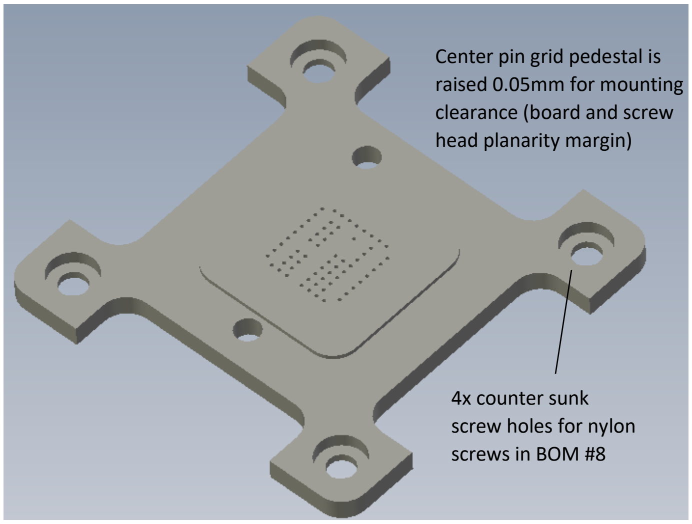


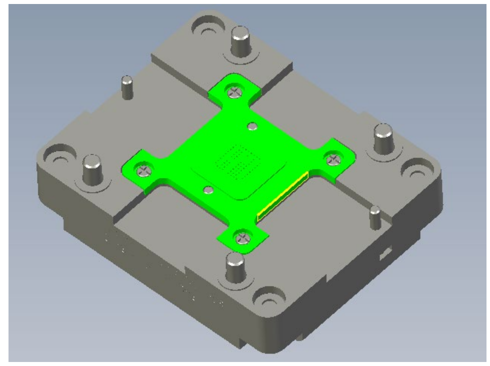
The center pin grid is recessed 0.05mm. Recessing the top of the drill hole gives the spring probes operating range to its ideal operating point.



3D View of Bottom Side of Top Pin Plate – Housing Frame

Bottom Pin Plate Description





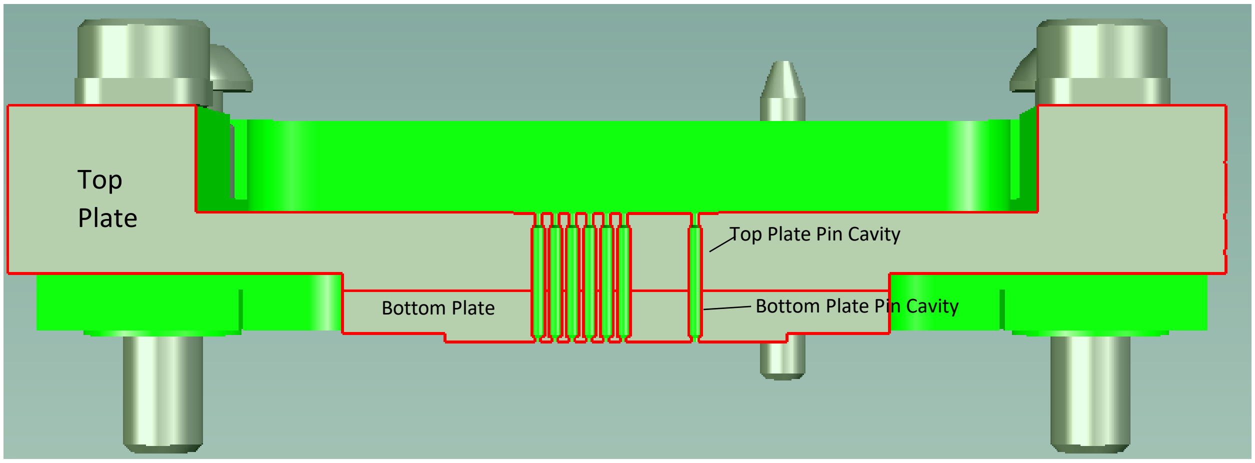
Board Side 3D View of Bottom Pin Plate (BOM #2)

The bottom pin plate is BOM item #2. This mounts to the bottom side of the housing frame (#1). The bottom plate captures the pins in the drill cavities and the bottom plate is screwed onto the top pin plate-frame. Nylon screws are used to mount this to ensure that if the screws are not properly seated in the counter sink receptacle, there is no issue with the top layer PCB traces or damaging the top layer solder mask. There is a slight pedestal around the pin grid that is 0.05mm lower than the rest of the socket frame when mounted on the board. This pedestal matches the ring machined around the through holes for the socket mounting screw. This produces a more precise socket mount for the probe pins *as only the smaller area on the pin grid and the seal rings around the through holes* needs to maintain the tightest planarity with the PCB board. This aids in maintaining the preload range on the PCB board pin grid to a very tight tolerance.

Pin Cavity

Below is a cross section of the socket to illustrate the pin capture. The cavity is built in two pieces from the top plate and the bottom plate. To load the socket probes. The top plate is set upside down on a flat, clean work area and the probes are positively oriented and inserted into each cavity with the device interface plunger facing down. The bottom plate is then slipped over the pin grid and the bottom plate screws tightened. The probes are now captured in the socket and should move freely.

For a socket to work well, properly drilling of the cavity is critical. Below is a cross section of the example socket showing a side view of some of the pin cavities.

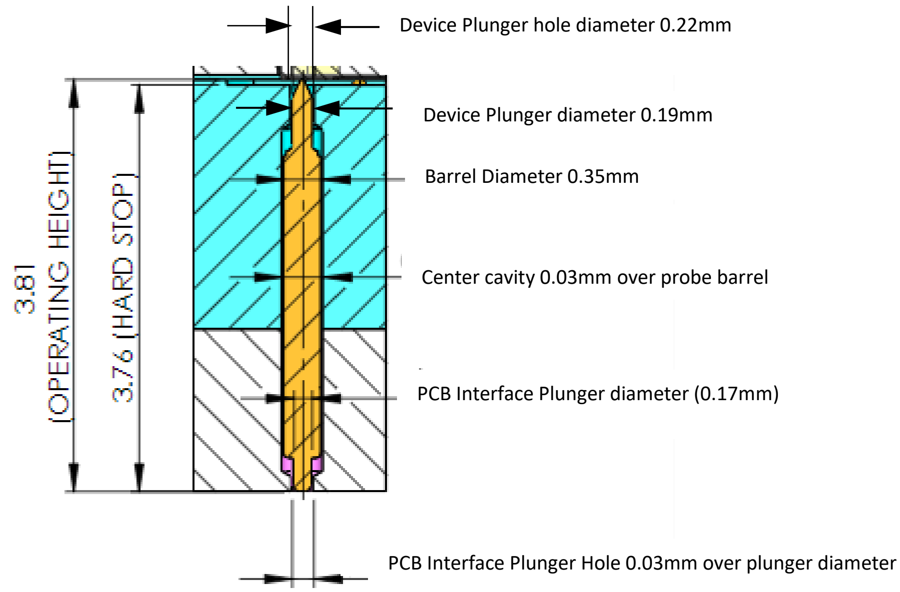


Cross Section of Pin Cavities

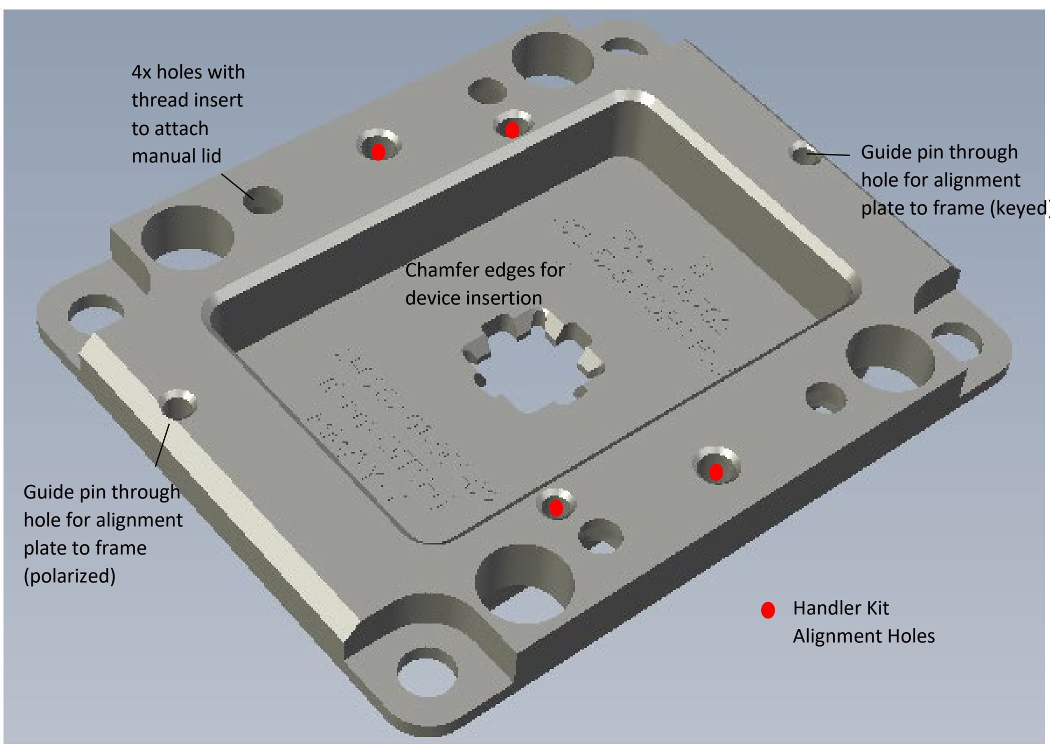
The B2501-SII probe has the DUT interface plunger integrated into the barrel. The plunger and barrel of the pin slides inside the pin cavity supported by the PCB interface plunger and spring. The cavity must be drilled precisely. It cannot be too tight so that pins on the upper tolerance do not bind. The cavity also can't be too oversized or risk the pin shifting side to side making contact at an angle. The top and bottom plate cavity registration must be precise and the transition from the top and bottom plate must be smooth. Signal integrity manufactures our drill bits specifically for the probe design of each socket. This leverages our spring contact probe manufacturing database to achieve the precision needed for the socket to operate for a high insertion count and with the pointing accuracy, reliable cycling, high first pass contact yield and very low wear contribution.

The illustration below shows the key dimensions that SII uses to machine the socket bottom and top plate probe cavities for the B2501-AF probe. Other socket designs will vary these dimensions to accommodate the specific probe, probe design, capture features, device specification and package variances. Note the recessed hard stop from the operating position.

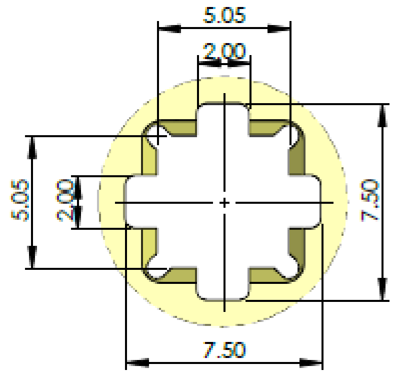
Cavity Detail



Guide Plate Description



The SII socket uses a separate guide plate (BOM item #7). The guide plate is specific to the test device package dimensions. When the guide plate is installed on the frame it forms the “socket” for the test device package. The chamfered walls of the center pocket guide and center the part onto the probe grid on the top plate (#1)



Device Pocket Features and Dimensions

The pocket contains insets on the corners and edges to support pick and place handler plungers and to aid manual insertion of the device with suction pens or gripping tools. Note the 5.05mm X-Y dimension. This is set to the maximum package outside dimension tolerance. The machining tolerance limit is +0.02mm to -0.00mm.

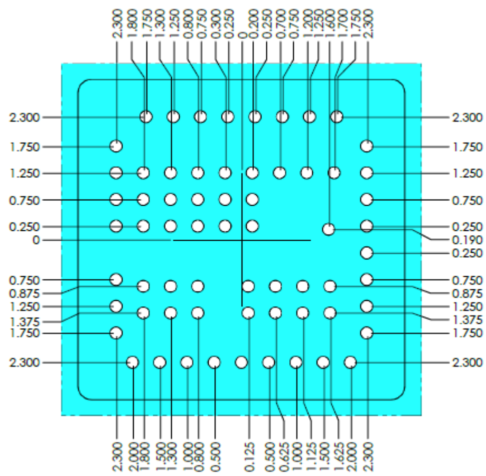
The guide plate has alignment holes for the frame guide pins. It is keyed so that the guide plate can only mount to the frame with a positive orientation. A pin one mark is etched on the guide plate where appropriate.

The guide plate has 4 holes each with an M2 stainless steel thread insert (BOM #6). These are used to attach the manual lid supplied from Signal Integrity (SI-xxxx-02).

There are also user specified alignment and guide holes to support various handler kit hardware. These are specific to the handler hardware and highlighted with the red dots in the 3D drawing

Probe Pin Locations

Accurately positioning the probe locations is the critical function of the socket. Each SII socket design has a probe quantity and probe assignment grid specific to the pin locations on the device package specification and PCB layout.



Package Pin Grid Locations (mm)

The device pin grid references the center of the package as (0,0). The package pin location centers are dimensioned on the grid as shown below.

The pin grid provides a position for all the probes that contact the part. This is a QFN, so the center grid pin positions are located to carry the return current with minimal GND return loop length to the PCB board. The center GND patterns can also be designed to optimize the channel impedance for high frequency performance. Sense pins and Kelvin pairs would also be included in the grid pattern. On this device one of the pins on the 8 pins in the top row is a sense pin for the high-power bus.

SII provides the PCB .DXF file for socket footprint to help create a library entry for the socket to use in PCB layout CAD programs.

Testing Matte Tin Pads

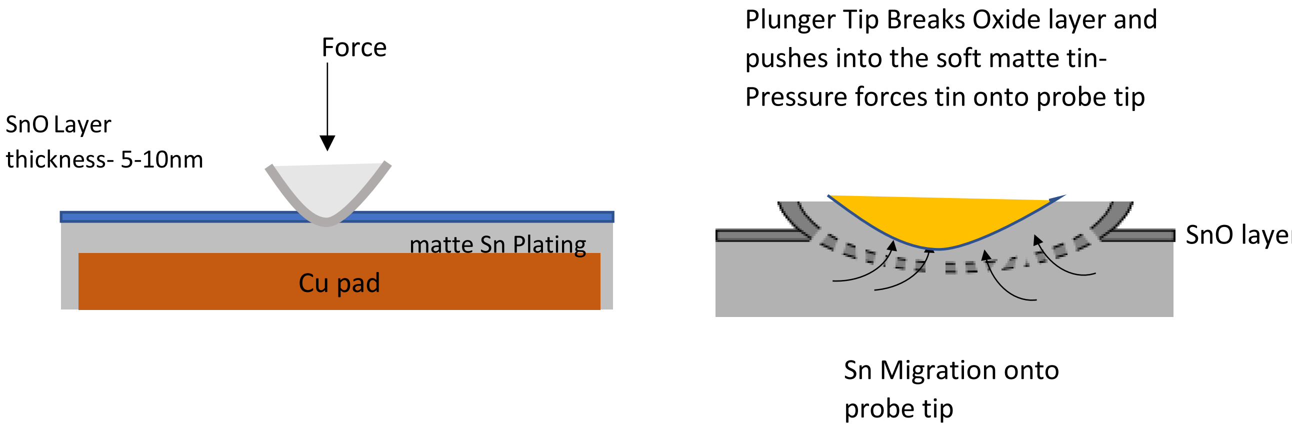
Tin will naturally form a hard, brittle oxide on its surface. This oxide is stable and forms moderately quickly when exposed to air. The oxide growth rate is temperature dependent.

SnO Thickness[1]

	Thickness (nm)	
°C	@10^3 hours	@10^5 hours
20	4.2	6.1
55	10.3	14.6
80	18.8	26.0
100	25.0	36.0

[1] 2012 BITS conference Tutorial, FUNDAMENTAL PROPERTIES OF ELECTRICAL CONTACTS, pg. 37, Dr. Ronald S. Timrit

Since this oxide is an electrical insulator, it must be disrupted to achieve a good electrical path for current to pass through the electrical interface. Fortunately, the underlying tin is much softer and more ductile than the tin oxide on the surface. With sufficient force, the probe tip will break through the oxide film. Unoxidized tin from the plating layer will then extrude through the cracks in the oxide, making good electrical contact. Here is a rough illustration of this process.



The contact pressure of the probe tip forces the tin on the device pad to migrate to the plunger tip. This tin will start to bond to the surface gaps on the plunger tips, The more porous the surface of the plunger, the tin accumulates in clumps and is then compressed back onto the pad, accumulating more material each pass.

Tin Plating has a hardness of Hv3 60. The Pd Alloy hardness is Hv3 510. Tin Oxide (SnO) builds up on the matte tin plating as soon as the pad is exposed to air. The Tin Oxide thickness is dependent on environment and time/and thermal gradient on the bottom of the device when testing above 125°C. Some measured oxide thicknesses are shown in the table above. Higher current through the pads also increases the oxide buildup. Power pins under high current conditions can suffer the worst migration since the contact surface area has very high current density. This momentarily softens the pad plating lowering the contact resistance but increasing the volume of material that will migrate. The tin that migrates onto the contact probe and collects on the tip surfaces, oxidizes a small amount as well. This adds another layer to break down during the tip compression cycle and creates an additional barrier to a low resistance contact.

If a matte tin pad or BGA package is driven into the socket floor with enough force, some soft tin debris will be compressed onto the socket floor between the pin holes. This tin debris can cause test issues if it forms a conductive path to GND or a short between pins. This can be an issue with Kelvin probes where the tips can be very close together. It is important with vertical spring probe sockets, to set the Z height to the socket operating position and not overdrive the pins. The socket plastic material like Torlon™ 5030 is hard and non-porous so the tin can be removed easily.

Cleaning and Socket Maintenance

Due to a wide range of variables, each test floor must determine their optimal cleaning and maintenance intervals through effective use of statistical process control. By carefully monitoring and recording yield rates and following good test floor troubleshooting procedures, the tool and process owners will be able to clearly differentiate between interface vs. maintenance problems and an effective maintenance cleaning cycle can be established to match the needs of each test floor.

Handler Design and Setup

Handlers have a variety of test plane configurations, device transportation methods, plunge mechanisms, alignment systems, setup software capability and accessories. Each handler has its own unique attributes. Handler set-ups that are not optimized will increase the maintenance frequency. Usually this is due to premature wear to the probe plunger tips on the device side or excess debris in the pin grid structure of the socket body forcing short cleaning cycles

Correct Contact Operating Height

The SII socket is designed so that the hard stop for the device cannot over compress or damage the spring probe. If the handler plunger mechanism drives the part to the hard stop there is a risk to the top plunger drill hole. The hole can be compromised, and the diameter of the hole distorted by the excess pressure of the device and material transfer from the DUT to socket pocket floor. The user should inspect the top of the socket pin grid to determine if the device plunger hole inside edge has clearance to the plunger tip. If there is no clearance, the tips may appear to be stuck. Care should be taken to set the plunger down force to match the amount of force needed to compress the probes to break the device pad oxide layer and create a good low resistance contact.

Package and Device Plating Variations

Variations in packages can affect your maintenance schedule. Different package vendors, or even different device lots, may have varying amounts of mold flash that can increase wear on the contactor guide plate and shift device placement. The pins are centered in the nominal pad locations and there is 0.05mm of variance allowed in the SII socket for package variance to the positive dimension. Also, the method used for plating the device can vary the rate of debris build-up and vary the maintenance interval.

Contaminants

Accumulation of contaminants on the contactor and/or load board (such as oxides and mold flash) will contribute to continuity and/or parametric failures during the test process.   Human sourced organic contamination can be another source of poor contact resistance issues.

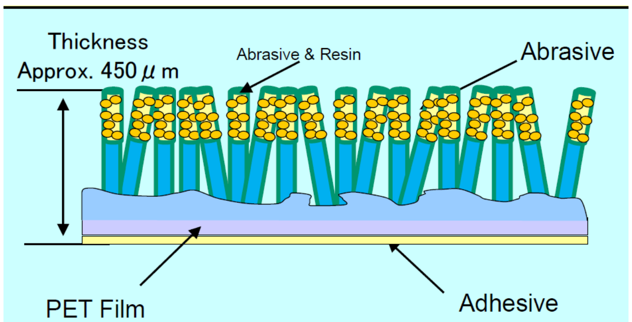
General Test Floor Maintenance Activities

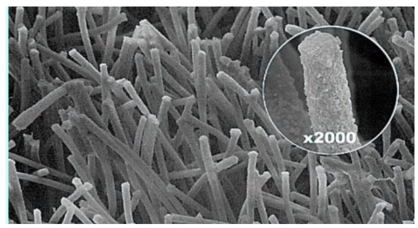
The frequency of handler maintenance procedures also affects contactor cleaning. For example, how often the handler and handler test areas are blown and vacuumed free of debris, impacts the effectiveness of the contactor. Contactors exposed to increased levels of foreign debris are likely to require more frequent maintenance and cleaning.

In Situ Automatic Probe Cleaning

During automated testing, the probe plungers accumulate material and debris from the contact pads on the device. The pressure at the contact area will force a bit of material migration to the B2501-AF plunger tip. This material builds up and impacts the ability to make a low resistance contact to the device. In a high-volume handler application, use a cleaning reticle such as a MIPOX™ pad for in sequence pin cleaning. The handler is set up to insert the MIPOX™ pad into the socket after a specified number of device insertions or a specified number of consecutive opens results.

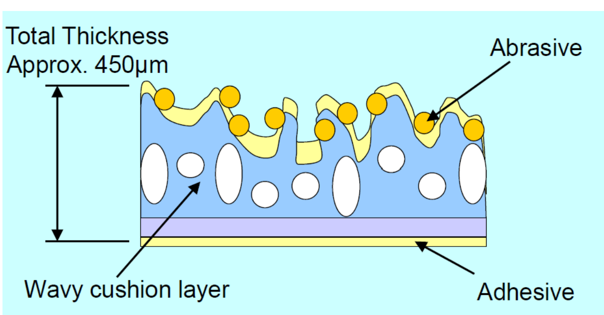
The B2501-AF uses a conic shape tip style, so an abrasive *Flocked Pile Type* MIPOX cleaning pad should be used (MIPOX # WA3000-FB GEY-A). This uses abrasive micro-brush fibers to push the debris off the tip.

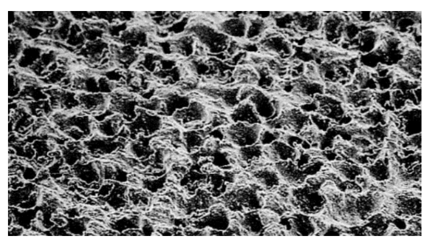




Abrasive Flocked Brush Pad

The B2501-AF can also use an SWE pad that combines a wavy cushion layer with an abrasive coating directly on top. This is a more aggressive cleaning pad and is used for crown tip plungers as well.





Abrasive Cleaning Pad (sponge like style)

One of the advantages of the B2501-AF homogenous plunger material is it provides a surface for more aggressive cleaning to Tin migration and other debris from the tips. The B2501-AF probe tips do not have a plating layer to wear away by the abrasive pads. There is also no nickel layer wear through and oxidize. Finally, there is no BeCu or Steel core to wear through and degrade contact resistance. The homogenous tip maintains the same material conductivity throughout the pin lifetime. The MIPOX pad cleaning cycle can be much shorter to keep the pins at the lowest contact resistance for these parts that require very low DC test values.

In Situ Inspection and Manual Cleaning

Removing debris and cleaning the probe tips when the socket is installed on the test board should be done with a vacuum, nylon brush, and clean compressed air.

The Guide plate (#7) should be removed using the 4 button head screws at location 9 which will expose the pin grid and allow for cleaning the top of the socket area. Inspect the pin grid for any damage to the probe tips or the drill holes. {Probe tips should move freely, and the drill holes around the probe tip should be circular).

If possible, a vacuum should be first applied to remove loose debris particles from the probe grid. Clean, dry compressed air can be blown across the area as well.
Use a pointed nylon brush to sweep along the probe tips. From the center of the grid to the outside.

Manual Brush Cleaning

- Remove the socket from the device interface board. These are the 4 socket head screws at item 10. Place the socket on the cover plate (item 5) so that the guide pins are recessed and there is a firm stable place to rest the socket. The cover is very important to protect the board side plunger tips while cleaning the device side plungers.
- Remove the alignment plate. These are the 4 button head screws at item 9.
- A nylon or fiberglass brush should be used to clean the probe tips.
- Use a firm brush stroke to polish the probe tips. Sweep the debris toward the outside of the grid.
    - Note a mild fluoride solution applied to the brush will bond with tin debris and help remove the migrated material contaminants from the probe tips.
- Use a vacuum to remove the debris. Keep the debris from the device side plunger drill holes
- A diluted Isopropyl Alcohol solution can be used with the brush to clean the Torlon surfaces of the socket frame.
- Clean the surface inside the frame on the top side of items 1. If a solvent is used, air dry with clean compressed air (20 PSI or less).
- Flip the socket and remove the cover.
- Clean the bottom side probes with the same procedure. The bottom side of the socket should be relatively clean as it stays fixed against the test board.
- Air dry with clean compressed air.
- Inspect contactor one final time for any debris, damage, or moisture.
- Remount contactor to load board.
- Video Demonstration of Dry Cleaning

Thorough Cleaning Procedure

If the probes and top frame housing plate have excessive debris buildup, it is recommended to perform a thorough cleaning with an ultrasonic cleaner. Only execute this procedure in a well-ventilated area with an exhaust hood. CAUTION: The ultrasonic cleaner should have a maximum power of 500W and a catch basket in the tank that prevents the contactor from touching settled debris.

Here is a link to a video demonstrating Signal Integrity's recommended deep cleaning method for the socket

[Cleaning Socket Probes to Reduce Contact Resistance](#)

Step 1: Setup for Deep Cleaning

- Remove the socket from the device interface board. These are the 4 socket head screws at item 10.
- Remove the Guide plate (#7). These are the 4 button head screws at item 9.
- If the probes are in good condition, they can be left in the socket housing during the deep cleaning procedures. Skip to step 3

Step 2: Remove and Replace Pins If Necessary

- If the spring probes require replacement remove the probes by turning the socket face down and unscrewing the 4 Phillips pan head screws at location 8.
- Gently slip the bottom plate off. The probes should all be seated in the top plate. Sometimes pins will travel with the bottom plate as well.
- Remove the probes by using a sharp pointed tweezer to grasp the plunger tip. Caution: Grasping the probe barrels will most likely cause the barrel to kink and ruin the probe. Grasp probes by the plunger tip only
- Replace the probes in the same manner. Device side plunger goes in face down into the top plate (#1)
- Reassemble the socket

Step 3: Rotary Brush and Cleaning Paste

- Apply a light dab of the special cleaning paste to a nylon rotary brush. (P/N SI-TP200-0S-1P). The cleaning paste consists of fluoride and mild abrasive.
- Using a light circular motion, run the rotating brush over the tips of the pins. Only gentle pressure is needed, the brush tips and cleaning paste do the work. This should only take about 15 seconds.

Step 4: Ultrasonic Water Rinse

- Prepare a bath of distilled water at room temperature. This will rinse the cleaning paste from the pin tips.
- Place the socket with the pins installed inside the water bath.
- Run this in the ultrasonic cleaner for approximately 5 minutes

Step 5: Ultrasonic Alcohol Rinse

- Prepare a bath of diluted Isopropyl Alcohol (70/30 Alcohol/ Distilled Water). This step will clear organic contaminants.
- Place the socket in the Alcohol solution. The guide plate can also be placed in the solution at this step.
- Run the ultrasonic bath for approximately 10 minutes.

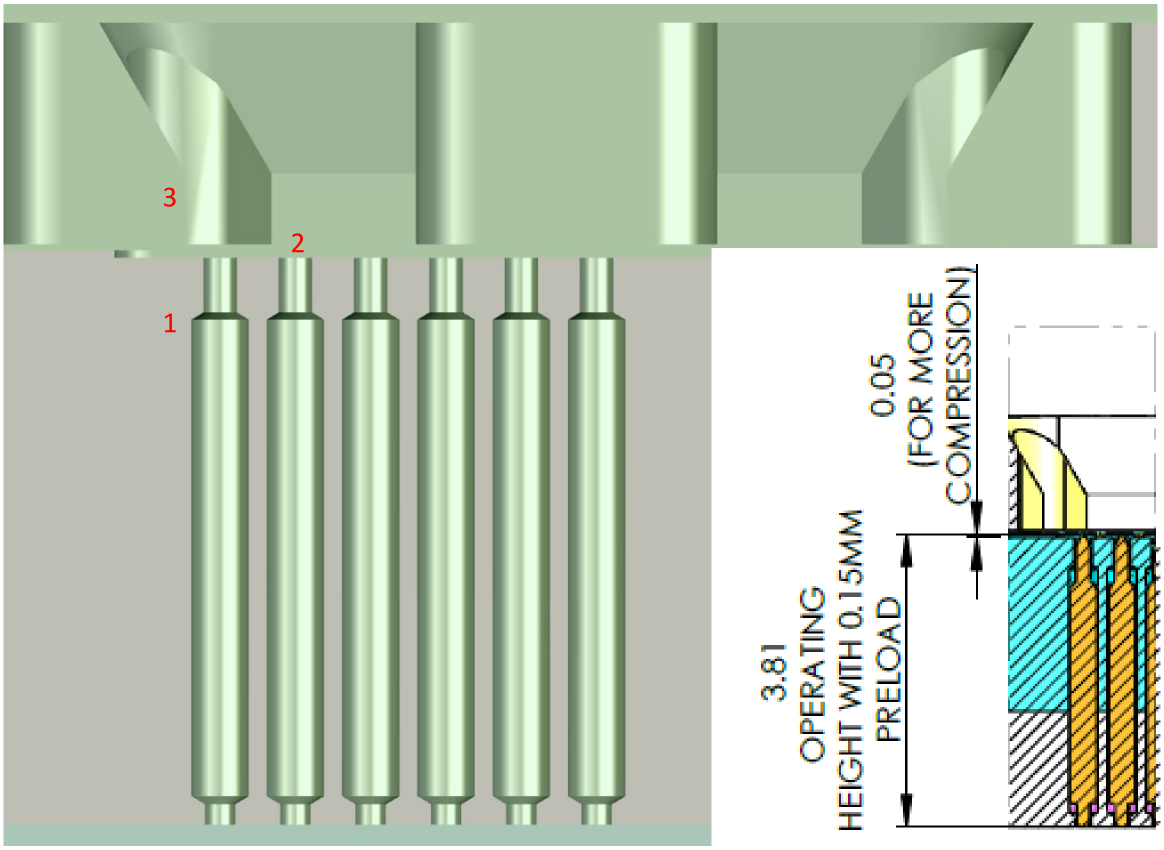
Step 6: Dry the Contactor

- Current leakage may occur during testing if moisture remains on the probes. To prevent this:
- Carefully pat the contactor dry with a lint-free cloth.
- Blow the contactor dry with heated air.
- If necessary, place in the oven for approximately 10 minutes.
- The socket material is rated to 260° C. Some caution should be used with the temperature used to dry the socket. Heated air should not exceed 150ºC or be utilized for longer than 30 minutes.

Socket Wear Points

The AF Socket has 3 wear points to monitor.

Wear point 1 is inside the cavity and can't be seen. Wear point 2 and 3 are visible on the pin grid and the guide plate.

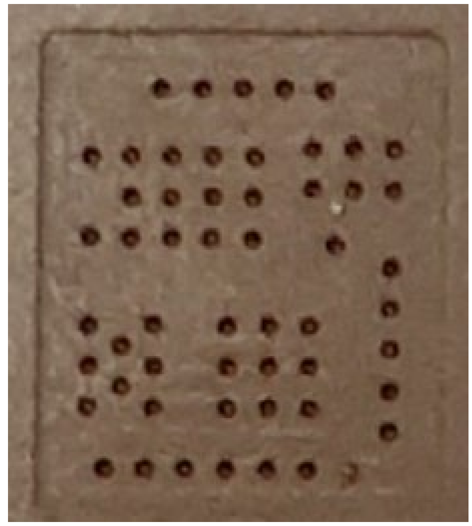


(1) This is the inside top barrel cavity. This surface is where the pin rests when it is at the initial length set in the cavity design. The pin is set with a total of 7.5gr of spring force for preload. The force at the top of the cavity is ½ the total force (3.75gr). The surface area of the contact is 0. 13mm^2. The B2501-AF has a hardness of 480 to 510 Vickers. The pressure on the inside of the Torlon™ 5030 cavity is (0.037N)/0.13mm^2 is 0.248MPa or 42.1 psi. Torlon 5030 has a compressive strength of 264 MPa and Rockwell hardness of E90. The plunger is much harder than the Torlon 5030 so there will be some wear. The Torlon compressive strength is 100x larger than the compressive force applied by the probe. The indentation from the plunger at point 1 is approximately 0.04mm over 1,000,000 cycles. Since this wear is not visible, the user should consider replacing the top plate if socket to board continuity becomes an issue after the 1.5M insertion count on the socket.

(2) Device plunger hole has been discussed in the maintenance section. Pressing the DUT down onto the socket floor with excess force will potentially deform the top drill hole for the device plunger. If the deformation is too large it will cause the probe tip to get stuck. This is a cumulative effect if the handler

plunge depth and down force is above the rated PSI of the socket. A 0.5mm pitch pin grid has enough mass in the plunger grid wall that a single over compression event will not damage the pin grid holes. C

Clean Plunger Holes without damage or debris



(3) Oversized devices and package flashing will rub against the vertical side wall of the guide plate. The metal on the side lead of the PQFN may also rub the walls of the guide plate. This will generate some wear over time but the Torlon 5030 is harder than the organic package material so it will be minimal and should not affect the utility of the guide plate and part alignment on the grid.

Probe Wear

The probe plungers wear down from vertical abrasion and friction with the device contact pads. This will occur over many insertions (>300,000). Contacting the matte tin plating on the device pad is abrasive and the contact pressure is high so the tips on a conic pin like the B2501-AF will wear down and become smoother. This reduces the total contact pressure on the device pad which can cause continuity issues.

Pins can also wear if there is a tilt or planarity issue with the part insertion that is repetitive and for a long duration. Tips may wear more on one side of the socket or on the edge differently than pins in the center of a grid. This is usually observed when the device is a large array, but small high-volume devices can wear pins unevenly since the volumes can be so high.

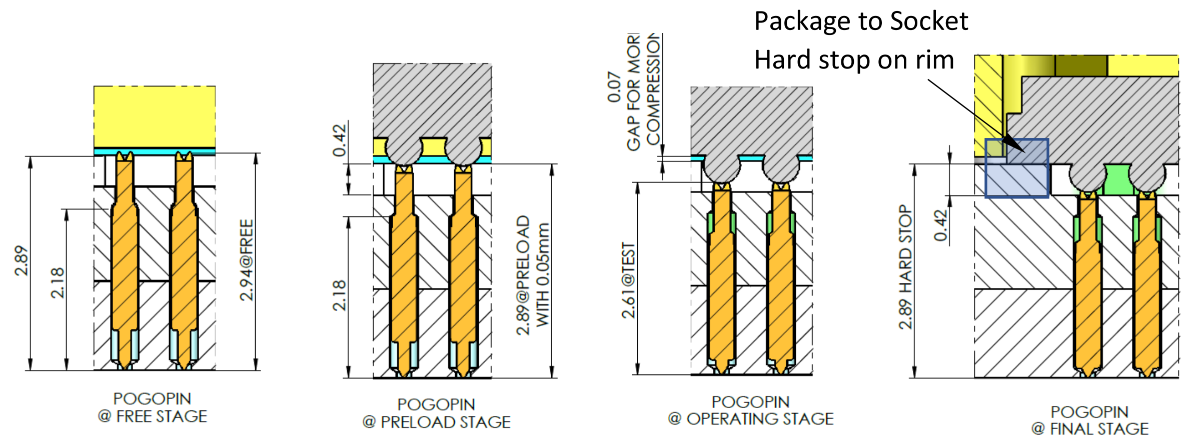
Pin wear can also be accelerated if the part slides in the pocket of the socket. The part scrubbing across the pin grid as it is compressed can be beneficial to help break the pad oxide layer.

The effect of wear on the plunger is that the contact surface area increases which reduces the pressure the tip can apply to break the device pad oxide layer. On matte tin pads, the soft tin is forced onto the probe tip by the contact pressure.

Setting Handler Z Depth

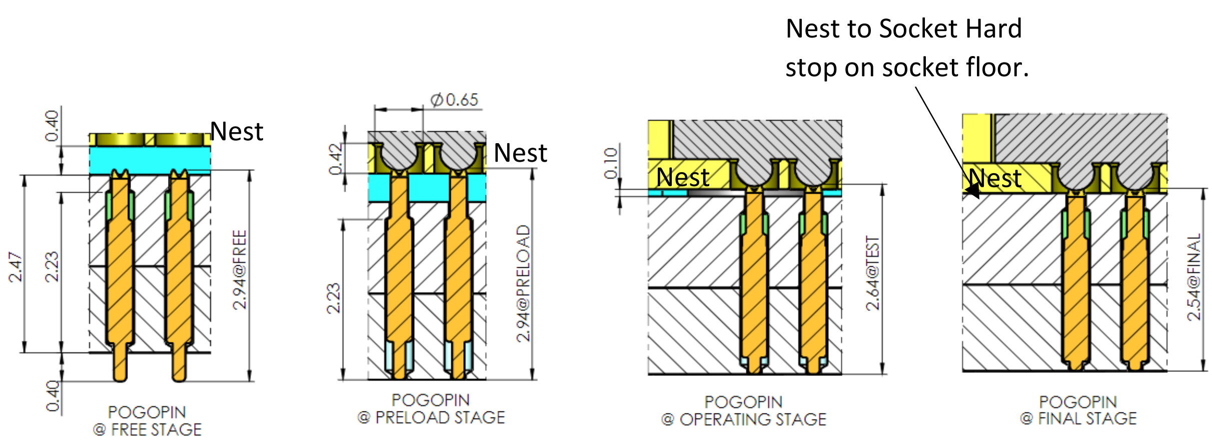
It is important with vertical spring probe sockets, to set the Z height to the socket operating position and not overdrive the pins. The Signal Integrity sockets design in a hard stop for the maximum insertion position that the handler plunger can apply down force on the package to compress the socket probe pins. BGA and Ball grid WLCSP packages usually have an outside rim that can be used to align and set the hard stop. Other large array packages use a floating nest for controlling the device Z depth in the socket. QFN, QFP and similar packages are more challenging. These parts need to be edge aligned and the pickup/plunger down force set to a level high enough to compress the springs in the grid

Example Socket Hard Stop for BGA package



B2514-V4 probe pin - BGA package Z Height simulation

Example Socket Floating Nest for BGA package



B2514-V4 probe pin - BGA package floating nest Z Height simulation

For a floating nest design, the part is placed into the nest and the part is aligned on the BGA balls in the nest's drill holes. The probe pins align with the holes in the net. The handler plunger forces the part and nest down compressing the pins. The nest rim sets the hard stop on the socket floor. The depth of the nest holes sets the probe operating length.

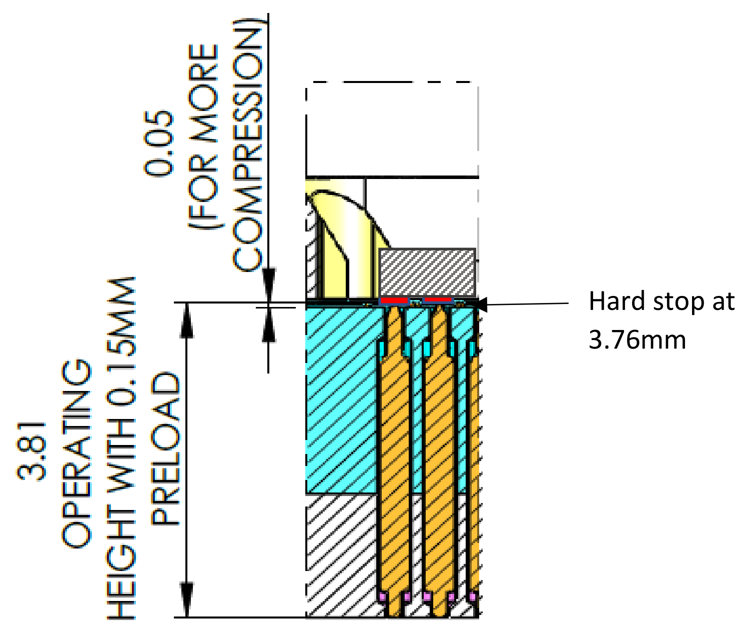
The nest sits on the float springs that also need to be compressed. The spring force for the nest will be specified for the device, probe selection and total probe force. The nest spring force must be added to the total pin force to properly set the plunger height back pressure.

For both types of sockets, the package rim and floating nest prevents the part from hard stopping on the socket surface and compressing the pin into the pin grid holes. This also prevents damage to the soft BGA balls (Sn)

The socket hard stop must work in conjunction with the stops and macro settings on the handler and handler setup kit Z height adjustment.

QFN, QFP, SOP Type Package Z Depth

For the high-volume packages like a QFN or other small SMT packages used in the SII socket design example in this manual, the use of a nest or package stop structures is not possible. For these packages the socket floor is the hard stop point for the handler pickup/plunger. This means that the handler insertion force must be set to compress the probe pins the (B2501) to operating height but not too high that the part is over compressed onto the socket floor. The force-Z depth target is 3.81mm which is the specified operating position of the B2501-AF probe. The socket allows for a 0.05mm additional compression on the probes.



QFN Package Z-depth

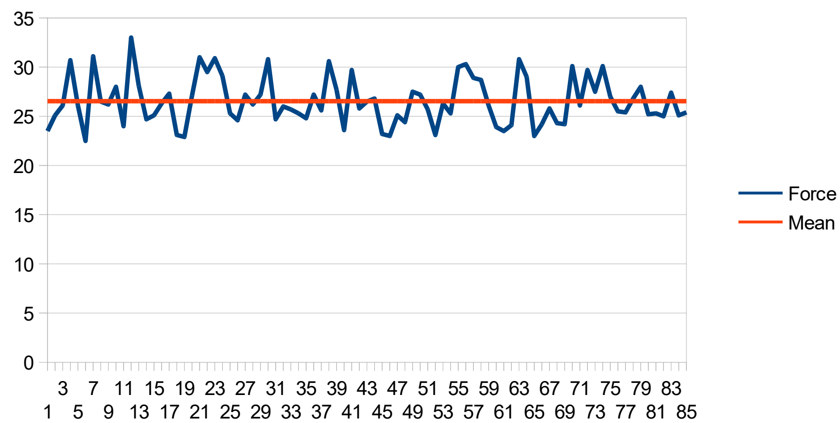
At 3.77mm length the probe spring compression stores a total force of 31gr (0.31N). There is 19gr available to contact the device pad, break the SnO oxide layer on the tin matte pad and force the pad/plunger extrusion-asperity surfaces to form a low resistance contact.

In the example socket, there are 65 B2501-AF probes (BOM #11). The total force to compress the 65 probe springs to the socket floor is 2.0 kg. This is simply the product of the total force (31gr) times the number of probe pins.

The spring force variance should be factored into the calculation for the Z depth compression. Finally, the margin calculation is outlined in the next section. For Z depth calculation, it would be justified to margin an additional 3 grams per pin to cover the high side force probability (50%). This adds another 200 grams to the handler plunger force. For this device a down force of 2.2kg (21.57N). For a pneumatic only set up, this is the equivalent of 16 psi for a 5mm^2 device.

Spring Force Variance on Signal Integrity Inc. Probe Designs

Spring force varies about +/-3 grams nominal and +/- 5 grams for the min to max range. For the B2501-AF, the targeted spring force at 3.81mm specified operating position is 28 grams



Above is a graph of spring force for a sample of 85 springs over 5 lots. The mean of the spring force is 26 gr (below the target 28gr specification) since the gauge setup does not include the side force vector for the plunger to barrel contact needed from the slightly bent spring in the barrel.

The springs demonstrate the same distributions per lot, so the spring construction is very repeatable. The spring design and manufacturing is very mature, and the material supply chain is well understood and stable. Springs of these small sizes and very small wire diameters, have published force variance as large as 20%

Signal Integrity tightens the total lot spread histogram over the manufacturer's published specification of +/-20% as tight as possible. SII has design and manufacturing IP developed from long association with this process which we use to help offset the manufacturer's variations and achieve better than manufacturing spec over a much larger proportion of the total lot size (about 1.5 sigma).

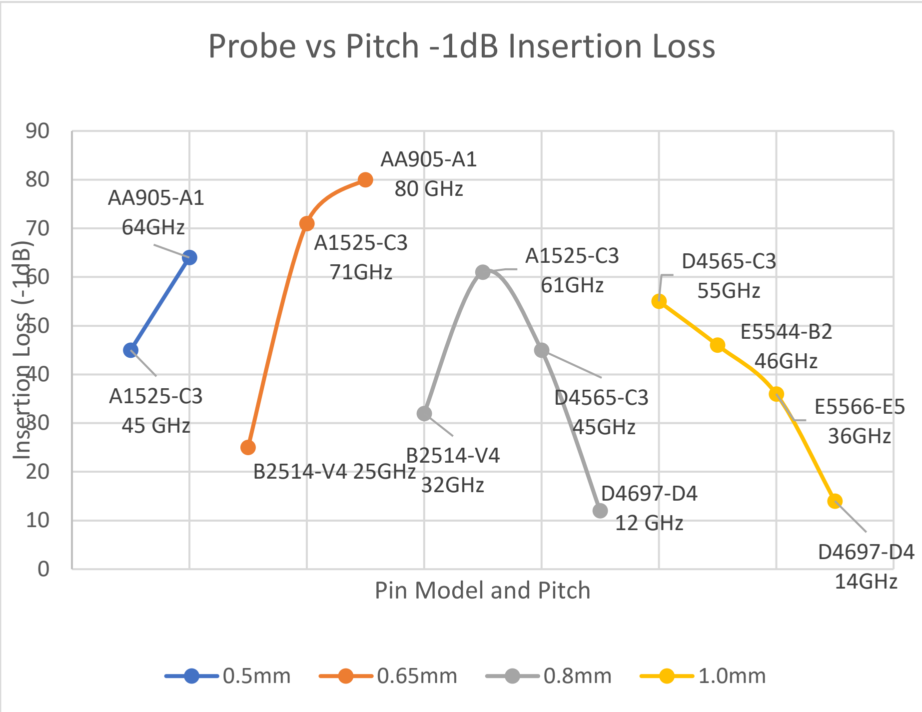
Signal Integrity

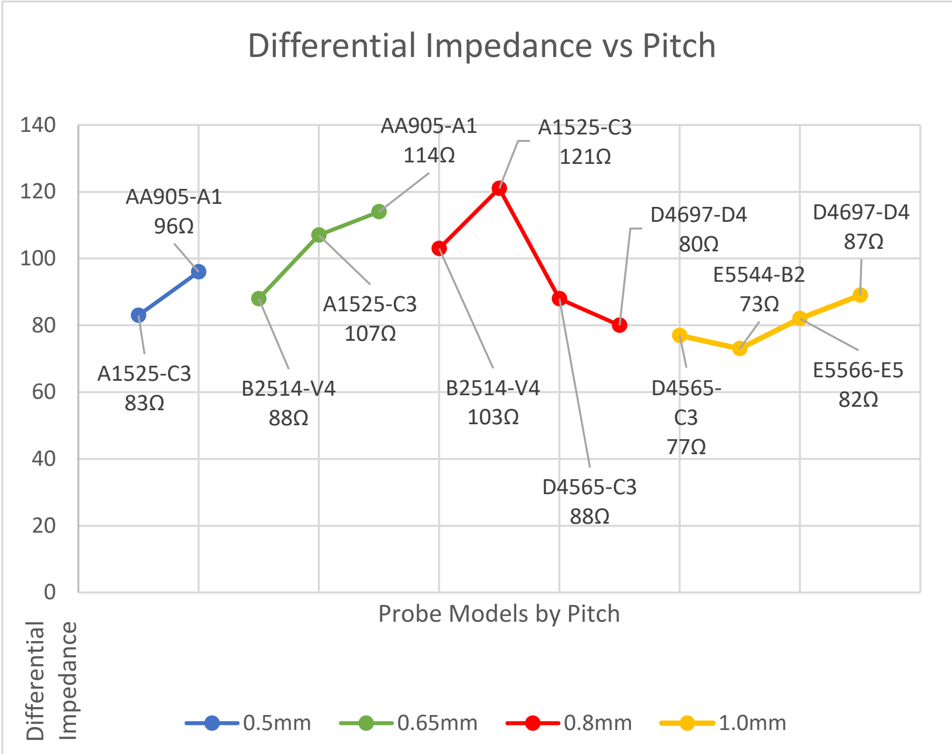
Applications Library for AF sockets

- Large Array BGA Sockets (AI, FPGA, Enterprise Server CPU, commercial CPU, GPU)
- High Volume Commercial SMT-Power Management SMT
- 5G commercial Telecommunications

Large Pin Count, High Bit Rate High Power Arrays

Package Application	Large pin count BGA			
	0.5mm Pitch	0.65mm Pitch	0.8mm Pitch	1.0mm Pitch
Probe Model	A1525-C3 AA905-A1	B2514-V4 A1525-C3 AA905-A1	B2514-V4 A1525-C3 D4565-C3 D4697-D4	D4565-C3 E5544-B2 E5566-E5 D4697-D4
Contact Surface	• Matte tin or bright tin solder balls • NiPdAu pads • Matte tin pads			
General Requirements for large Pin Count BGA	These packages require the socket to be able to handle large power consumption tallying 100s of Watts, complex very high NRZ bit rates above 20 Gb/s and PAM4 bit rates above 54 Gb/s. Very large arrays (>40mm$^{2)}$) have planarity to consider as well as large total contact forces. T			





Probe Model	Continuous Current	Contact Resistance (mΩ)	Operating Length Range (mm)	Total Force at OP (gr)
AA905-A1	1.5A	110	0.33	20
A1525-C3	1.7A	60	0.22	21
B2514-V4	2.4A	90	0.35	26
D4697-D4	3.0A	45	1.2	32
D4565-C3	8.3A	25	0.44	30
E5566-E5	4.3A	20	0.33	34
E5544-B2	3.0A	30	0.46	30

Very High Volume Commercial and Automotive Surface Mount Packages

Package Application	Very High-Volume Commercial Surface Mount Devices		
	0.3mm Pitch	0.4mm Pitch	0.5mm Pitch
Probe Model	AA905-A1 AA9-5-C3 AA927-F6	AA905 A1550 A1540 A1561	B2501 B2514 B2503 A1561 A1550 A1540
Contact Surface	Matte Tin		
General Requirements for High Volume SMT	Very High Insertion Counts, Probe Reliability, Ease of Maintenance, Current Capacity for power management applications, low contact resistance. Tests often need low current measurements or Kelvin connections		

SII Probe Model Overview for High Volume Test

Package types: QFN, PQFN, VQFN, QFP, DFN, DFP, TSSOP, SOP, SSOP.

Package Application	Very High-Volume Commercial Surface Mount Devices		
	0.3mm Pitch	0.4mm Pitch	0.5mm Pitch
Probe Model	AA905-A1 AA905-C3 AA927-E5 AA927-F6 AA909-B2 AA909-C3	A1550-B2 A1550-W5 A1540-D4 A1540-E5 A1561-DE A1561-K2 A1580-B2 A1512-AC	B2501-AF B2501-DE B2514-B2 B2503-D4 B2503-FG B2503-AB
General Features	Stainless Steel Spring, Adjustable spring force, Ogive, reduced crown and conic tips, Pd Alloy and Gold-Plated Tool Steel Interface Plungers		

Probe Features

Probe Model	Continuous Current	Contact Resistance (mΩ)	Operating Length Range (mm)	Total Force at OP (gr)
AA905	1.5A	110	0.33mm	20
AA927	1.5A	90	0.20mm	22
AA909	1.0A	72	0.25mm	17
A1512	2.0A	72	0.30mm	24
A1550	2.0A	85	0.20mm	29
A1540	4.3A	25	0.35mm	29
A1562	1.45A	20	0.38mm	30
A1580	1.55A	30	0.49mm	32
B2501	2.8A	50	0.24mm	28
B2503	1.7A	60	0.42mm	28
B2514	2.0A	90	0.26mm	26

Low Pin Count RF Packages

These devices are like the high-volume socket family except SII designs in structures and tunes the impedance to achieve the frequencies required by the application. These sockets may require additional GND pins or shield structures to minimize cross talk, stacked layers to control impedance and engineering choices in material and close integration with the device PCB board layout. These devices are typically smaller pin count surface mount QFNs and small flip chip WLCSP BGA devices. These parts can have very high volume as well.

Package Application	RF Surface Mount Devices		
	0.3mm Pitch	0.4mm Pitch	0.5mm Pitch
Probe Model	AA905-A1 AA905-C3 AA927-E5 AA927-F6	AA905-A1 AA905-C3 AA927-E5 AA927-F6	AA905-A1 AA905-C3 AA927-E5 AA927-F6 A1540-D4 A1540-E5 A1561-DE A1512-AC
General Features	Stainless Steel Spring, Adjustable spring force, Ogive, reduced crown and conic tips, Pd Alloy and Gold-Plated Tool Steel Interface Plungers		
Socket Features	3D Simulation, Crosstalk Isolation, Impedance Tuning, Via to Pin transition modeling. Package GND return optimization.		