Bonding Capillaries

Bonding Evolution

The SPT Roth Group’s strategy centers on developing the Company into an integrated global corporation. Over the last twenty years, we have built on our global vision and invested in building manufacturing and sales facilities strategically around the world to be close to our customers.

The worldwide network combined with excellent logistic facilities ensures prompt and full compliance with customer requirements including ship-to-stock or just-in-time delivery programs. Dedicated and highly qualified sales and service engineers and application specialists ensure that customers receive professional service and support at all times from the design phase to starting mass production.

SPT is open around the world, round the clock.
SPT is the pioneer and leader of semiconductor bonding tools for over three decades. SPT is the only bonding tool manufacturer internationally established with marketing and production centres strategically positioned all over the globe, to be close to our customers.
Customer partnership is our belief. At SPT, we listen to our customers. Because, every customer’s needs are different, every solution is uniquely designed to satisfy those needs in the most effective way.

SPT offers a wide range of proactive support and services such as consulting, design, analysis, training seminars and benchmarking partnerships. SPT’s material and process technology laboratories in Switzerland and Singapore offer technical support and services such as material analysis, process evaluation and characterization and tool design optimization.
SPT is committed to quality and customer care. Our commitment to product excellence and continued support of our customers is part of the sustaining culture of SPT.

SPT’s partnership philosophy has earned numerous prestigious awards and recognition from our customers.
SPT positions itself as a progressive high-technology tool manufacturer using state-of-the-art processes. Our production capabilities range from conventional to CNC machining including milling, turning, surface grinding, honing, Electro-Discharge Machining or EDM, jig grinding and more. Our exclusive Injection Molding technology of small complex parts through SPT’s own in-house formulation and sintering assures customers of the highest quality in high alumina ceramic and carbide materials.

Our equipment and manufacturing techniques are the most advanced in the ultra precision tool industry.

We make standard and custom designs for specific customer requirements. All tools meet the high precision dimensional and quality standards maintained by Small Precision Tools.
The new generation of advanced electronics packages has driven the development of the wire bonding technology to its full limits. Innovative package miniaturization approaches have been concertedly developed to deal with its physical limitation. The end results is a compact, and lighter device with increased I/O’s. Important factors such as higher reliability and possibly at a lower cost, the need for higher integration, higher speed, higher pin count and more features were all considered in the overall package design. This has posed a great deal of new challenges and innovation in the wire bond interconnect technology to develop a new generation of wire bonders; process development and characterization/optimization of new material; and manufacturing and finishing process of ultra-fine pitch wire bonding capillaries. Presently, the packaging technology has reached the sub-50 micron bond pad pitch (BPP) device level in a production mode.

The face-up wire bonding method has been the mainstream for bonding bare IC like SOP and QFP lead frames. However, the newer process packaging method has emerged, which utilizes a face down flip chip bonding typically used for some ball grid array (BGA) and chip scale package (CSP) - wire bonded packages.

The conventional wire bonding method of having low loop, and long wire span for high pin count for QFP or BGA package types have been the source of noise and delay in signal processing, which directly affects the speed performance of the device. The low-loop and short wire benefits of CSP wire-bonded package have increased the device capability to handle higher frequencies for processing GHz band signals. To further enhance the processing speed, there is a need to integrate copper wire with low-k and ultra low-k dielectric material.

Small Precision Tools (SPT) has equipped and positioned itself to meet these new packaging technology challenges by providing to customers with robust capillary product using the state-of-the-art Ceramic Injection Molding (CIM), an optimized ceramic material and a nanotechnology finishing process.

SPT capillaries are designed based on a given device/package application type, and are optimized to produce consistent and repeatable wire bonding process. Careful consideration is given to the determination of critical tolerances for various capillary dimensions. Customers are therefore assured of high quality standards and conformity to the specifications. All of these benefits are essential to achieve a wider process window resulting to a robust process.

SPT’s DFX, Programmed Intelligence (PI), Stitch Integrator (SI) and Slimline Bottleneck (SBN) capillary series are popular choices for most of the semiconductor companies manufacturing fine-pitch and ultra-fine pitch devices. The UTF, UTS, UTE, and CSA series are common choices for non-fine pitch application. They are adaptable to any of the commercially available wire bonders in the market- whether using a 60KHz, or >99KHz transducer horn frequency.

SPT positions itself as a progressive high technology manufacturer of ultra-precision parts and continue to remain as a world leader in semiconductor ceramic bonding tools, continuously providing high quality products and excellent services to our valued business partners.
Thermosonic tailless ball and stitch bonding is the most widely used assembly technique in the semiconductor to interconnect the internal circuitry of the die to the external world. This method is commonly called, Wire Bonding. It uses force, power, time, temperature, and ultrasonic energy (sometimes referred to as bonding parameters) to form both the ball and stitch bonds. Typically for the ball bond, the metallurgical interface is between gold (Au), and aluminum (Al) bond pad (typically with 1% silicon (Si) and 0.5% copper (Cu). As for the stitch bond, it is bonded to a copper alloy with thin silver (Ag) plating.

The ultrasonic transducer (typically for new generation of wire bonders, the piezoelectric element is >100KHz), which converts the electrical energy into mechanical energy, transmits this resonant energy to the tip of the bonding capillary. The capillary that is clamped perpendicularly to the axis of the transducer-tapered horn is usually driven in a y-axis direction vibration mode.

Bonding capillaries are made of high-density Alumina ceramic material, Al2O3, typically 1/16” (.0625” / 1.587mm) in diameter and .437” (11.10mm) in length. The final capillary design depends upon the package/ device application and wire diameter to be used. To determine the correct capillary design in general, bond pad pitch (BPP), bond pad opening (BPO), target mashed ball diameter (MBD) are the essentials.

A fine gold wire made of soft, face-centered-cubic metal (FCC), usually ranging from 18µm to 33µm in diameter (depending upon the device/ package application) is fed down through the capillary. It is usually characterized by its elongation (shear strain), and tensile strength (breaking load). Selection of the appropriate wire type to be used for a given application would be dependent on the specification of these elongation, and tensile strength. In general, the higher elongation (or higher strain), it means that the wire is more ductile. This is a good choice for low-loop, and short wire type of wire bonding application. If the requirement is for higher pull strength readings, a harder wire type having a higher tensile strength has to be considered.

The small incursions of ultrasonic energy at the tip of the capillary are transmitted to the Au ball and down to the Al bond pad to form the ball bond. After which, the capillary lifts up and form the looping profile, and then comes down to form the stitch bond. This cycle is repeated until the unit is bonded.

An intermetallic compound, Au-Al, is formed when the Au is bonded thermosonically to the Al bond pad metallization. The metallurgical interface of void free Au-Al formation has a significant increase in the shear strength readings of the ball bonds tested provided that there are no impurities present in the bond interface even if it has been exposed to high temperatures. However, if the impurities in the interface are welded poorly, the ball shear strength produces a significant degradation in its readings.
The ball bonding process starts off with the wire clamp open and a free air ball at the end of the wire, which is protruding outside the capillary tip.

To achieve consistency of the free air ball size, it requires consistent tail length after second bond formation, and consistent electronic flame-off (EFO) firing.

A wire tensioner is used to ensure that the free air ball is up and at the center of capillary face prior to being lowered onto the die bond area. If this condition is not met, a chance of producing an irregular ball bond deformation commonly known as “golf club ball bond”.

The capillary is lowered with the free air ball at its tips’ center, and initial ball deformation is made by the application of impact force. The application of the ultrasonic energy, force, temperature and time enabled the initial ball to be deformed further to the geometrical shape of inside chamfer, chamfer angle and the hole.

After the ball bonding, the capillary raises, looping takes place as the capillary travels at the same time from the first position of the ball bond to the direction of the second bond to form the stitch.

The looping can be varied to a different modes depending upon the device / package type. Achieving low-loop, long lead bonding is no more a problem because of the programmable looping algorithm that optimizes its formation for each different lead length.

Once the capillary reaches the targeted second bond position, the stitch is then formed with similar factors applied during the first bond. The capillary deformed the wire against the lead or substrate producing a wedge-shaped impression.

It is important to note that a certain amount of tail bond is left to allow pulling of the wire out of the capillary after the stitch bond formation in preparation for the next free air ball formation.

The capillary lifts up with its tail protruding outside the capillary tip. This action would then enable the electronic flame off to be activated and a free air ball is again formed ready for the next bonding cycle.
One of the basic principles to achieve an optimized wire bonding process is through a proper capillary design selection. The synergy of different process variables coming from wire, substrate, bond pad metallization, and wire bonder is influential to final geometrical design of the capillary.

The capillary selection process starts with the determination of the following information to determine the most suitable device / package design configuration:

**Bond Pad Pitch (BPP)** - is defined as the center distance between two adjacent bond pads. Specifically for ultra-fine pitch application, the BPP dictates the design of tip diameter (T), bottleneck angle (BNA) and chamfer angle (CA).

![Diagram of Bond Pad Pitch (BPP)](image)

**Bond Pad Opening (BPO)** - is defined as the unpassivated area of the bond pad where the actual ball bonds are ultrasonically welded.

![Diagram of Bond Pad Opening (BPO)](image)

**Critical Loop Height (CLH)** - is defined as the height of the loop that is in-line with the centerline of the capillary when viewed from the side or parallel to the adjacent wire. Once the wire passed the centerline, the capillary has already cleared and no adjacent loop disturbance is observed.
Capillary dimensions directly affecting the ball bond formation

- **Hole Size (H)** is determined based on the Wire Diameter (WD) to be used in a given application. Typically, the ratio is around 1.2X to 1.5X of the WD. A smaller hole size ratio is necessary for ultra-fine pitch application to compensate for the smaller chamfer diameter requirement.

- **Chamfer Diameter (CD)** is determined based on the targeted Mashed Ball Diameter (MBD). Normally, the MBD is restricted by the bond pad-opening dimension.
**CAPILLARY DESIGN RULES**

- **Chamfer Angle (CA)** provides a certain amount of squash out in the formation of MBD. It also controls Free Air Ball (FAB) centering during its impact. Typical chamfer angle is 90°.

Inner chamfer grips the initial free air ball during the transfer of ultrasonic energy.

The combination and interaction of the hole size, chamfer diameter, chamfer angle, and inner chamfer determines the total amount of volume necessary to form the ball bond. The total volume of the FAB must be greater than the volume created by the above combination so that enough gold material is squashed out of the chamfer area to form the desired MBD.

**Typical Capillary Hole Size Selection**

The proper selection of hole size for a given wire diameter is vital in the design of the capillary. This applies not only for fine pitch application but also for standard designs. Table 1 summarizes the recommended combination, which would provide better control and consistent looping profile.

<table>
<thead>
<tr>
<th>Given Wire Diameter (in µm / inch)</th>
<th>Hole Size (in µm / inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 / .0007</td>
<td>23 / .0009 – 25 / .0010</td>
</tr>
<tr>
<td>20 / .0008</td>
<td>25 / .0010 – 28 / .0011</td>
</tr>
<tr>
<td>23 / .0009</td>
<td>28 / .0011 – 30 / .0012</td>
</tr>
<tr>
<td>25 / .0010</td>
<td>33 / .0013 – 38 / .0015</td>
</tr>
<tr>
<td>28 / .0011</td>
<td>35 / .0014 – 38 / .0015</td>
</tr>
<tr>
<td>30 / .0012</td>
<td>38 / .0015 – 41 / .0016</td>
</tr>
<tr>
<td>33 / .0013</td>
<td>43 / .0017 – 46 / .0018</td>
</tr>
<tr>
<td>38 / .0015</td>
<td>51 / .0020 – 56 / .0022</td>
</tr>
<tr>
<td>51 / .0020</td>
<td>64 / .0025 – 68 / .0027</td>
</tr>
<tr>
<td>64 / .0025</td>
<td>75 / .0030 – 90 / .0035</td>
</tr>
<tr>
<td>75 / .0030</td>
<td>90 / .0035 – 100 / .0039</td>
</tr>
<tr>
<td>100 / .0039</td>
<td>127 / .0050</td>
</tr>
<tr>
<td>127 / .0050</td>
<td>178 / .0070</td>
</tr>
</tbody>
</table>

Table 1
In ultra-fine pitch ball bonding, the consistency of the mashed ball diameter (MBD), looping, and stitch bonds are essentially required in order to define a robust process.

The following considerations are important to produce a consistent MBD:

1. Consistent and symmetrical free-air-ball (FAB) is important to produce a consistent MBD.

2. Correct capillary design considering the hole size, chamfer diameter, chamfer angle, wire diameter, targeted MBD, and mashed ball height (MBH).

3. Controlled impact or initial force is needed for better control and consistent ball height.
Consistency of the Small Ball Bond Deformation

The continuous growth in the development of new packaging technology has posed a greater challenge for wire bonding process to optimize the ball and the stitch bonds. Maintaining consistency in the formation of bonds is the key to success. To attain a consistent small ball bond deformation, the following are essential consideration:

- Optimum capillary design selected - typically, the hole size, chamfer diameter, and chamfer angle are the major dimensions in consideration. A 90° chamfer angle (CA) as a standard; given a hole size (H)= WD + 8µm as the minimum; and chamfer diameter (CD)= H + 10µm as the minimum.
- Consistent free air ball and wire diameter aspect ratio - around 1.6 to 1.7x WD range.
- Consistent tail length protruding outside the capillary tip after the second bond
- Consistent electronic flame-off firing to form the free-air ball.
- Maintaining adequate gap between the tail and the EFO wand to prevent shorting or open wire problems.

Consistent EFO firing to form consistent free-air ball  
Consistent tail bond after stitch bond
The wire bonder looping software influences the looping profile. The new generation of wire bonders are programmed with different looping profile with capability to handle sharp bends, low and high trajectory. This will depend on what particular package type is being bonded. The clearance between the wire and the capillary hole must be greater than 4µm to ensure that there is no friction or resistance during looping.

In-line Gold Ball Bonding

The commonly used bond pad configuration is the in-line pattern where all the wires are bonded in a single row. This has given some constrains in the geometrical design of the capillary - specifically the tip diameter. The design of the tip diameter is dependent on the bond pad pitch dimension - the more number of in-line bond pad, the smaller the tip diameter will be used. As previously mentioned, having a smaller tip diameter will affect the amount of stitch length formed which is a critical consideration in the ultra-fine pitch application.
The fine-pitch and ultra-fine pitch multi-tier gold ball bonding has been designed and developed to incorporate higher density package interconnection by putting multiple rows of bond pad adjacently on top of one another. The center of the bond pads of the rows is alternately positioned so that the effective bond pad pitch of adjacent pads is greater than the one on top. (Example: A bond pad pitch of 35µm has an effective bond pad pitch of 70µm considering the staggered position of the bond pads). With this, a larger tip diameter capillary design can be considered, as for this case the basis will now be the 70µm & not the 35µm pitch.

In actual application, looping profiles for the multi-tier bonding should be also considered. Unlike in the single row in-line bonding, it usually requires a combination of high and low looping to prevent wires from touching one another. Normally, the inner rows of the bond pad will have a higher looping as compared to the bond pads below.

Advantages of multi-tier gold ball bonding:
- Reduced die size
- More I/O’s
- Increase in speed and frequency of the device
- Higher density interconnection
- Enable to use a larger tip diameter capillary design
- More stable and longer stitch length
- Capability to use the current wire bonding process
- Utilization of the wire bonding equipment
The length of the stitch bond is influenced by the capillary tip diameter. The size of the tip diameter is dependent upon the device bond pad pitch dimension. For ultra-fine pitch application, the considerations for good stitch bonds (which means higher pulls strength readings) are the following:

**Capillary dimensions directly affect the stitch bond formation**

- Tip Diameter (T) determines the amount of Stitch Length (SL).

- Outer Radius (OR) provides a proper heel curvature of the stitch bond to minimize heel cracks.

- Outer radius (OR) must complement face angle (FA) design for given small tip diameter (T) - to provide an adequate thickness and smooth transition of the stitch.
• Controlled impact force for stitch is essential to promote a more reliable adhesion between the stitch and the substrate or leads.

![Stitch showing an over bond condition due to high impact force](image)

• Good surface finish for lead frame or substrate to provide good metallurgical Au adhesion. A variation in the surface roughness causes the lifted stitch/ non-sticking problem.

![Roughness variation showing lifted stitch problem](image) ![Surface roughness on Au substrate](image)

• Capillary tip load-up shortens its life span as well as causing thinning of the stitch bond.

![Capillary load-up causing stitch reliability problem](image)
Face Angle (FA) provides a certain level of thickness of the stitch bond with a proper combination of OR transition. This is typically 8° for non-fine pitch and 11° for fine to ultra-fine pitch applications.

Inner Chamfer (IC) bonds the necessary tail length before detaching it from the stitch bond in preparation for the next FAB formation.

**Typical Capillary Tip Diameter and Outside Radius Design Combination**

Another important consideration in the design of the capillary is the correct combination of outer radius (OR) and the tip diameter (T) with a given face angle (FA). This combination would ensure a smooth transition of the stitch bond as it guarantees that the outer radius (OR) would not nullify whatever face angle design applied, given the tip diameter design. Table 2 shows the typical T and OR combination.

<table>
<thead>
<tr>
<th>Tip Diameter (in µm / inch)</th>
<th>Outer Radius `OR' (in µm / inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 / .0022</td>
<td>8 / .0003</td>
</tr>
<tr>
<td>60 / .0024</td>
<td>8 / .0003</td>
</tr>
<tr>
<td>66 / .0026</td>
<td>10 / .0004</td>
</tr>
<tr>
<td>70 / .0028</td>
<td>10 / .0004</td>
</tr>
<tr>
<td>75 / .0030</td>
<td>12 / .0005</td>
</tr>
<tr>
<td>80 / .0031</td>
<td>12 / .0005</td>
</tr>
<tr>
<td>90 / .0035</td>
<td>12 / .0005</td>
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<tr>
<td>100 / .0039</td>
<td>12 / .0005</td>
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<td>130 / .0051</td>
<td>30 / .0012</td>
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<tr>
<td>140 / .0055</td>
<td>30 / .0012</td>
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<td>165 / .0065</td>
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<td>300 / .0118</td>
<td>64 / .0025</td>
</tr>
<tr>
<td>330 / .0130</td>
<td>64 / .0025</td>
</tr>
<tr>
<td>360 / .0142</td>
<td>75 / .0030</td>
</tr>
</tbody>
</table>

*Table 2*
Capillary material selection process consist of the following considerations:

- **Small grain size**: The microstructure of SPT’s ultra-fine grade ceramic material is a polycrystalline solid. Composed of a collection of many ultra-fine single crystals, separated from each other by their narrow grain boundaries. The growth of the grain boundaries is well controlled using the SPT’s state-of-the-art sintering and densification processes. Small grain size feature makes the surface finishing of the ceramic material smoother, and consequently reduces the wire drag effect in the wire passage inside the capillary.

- **Higher density**: It refers to the mass of the polycrystalline ceramic solid having uniformly controlled grain sizes (with less impurities), compacted to a constant volume considering the ceramic’s random crystallographic orientation during the densification process after the capillaries have been injection molded and sintered. This is an essential process to achieve high ceramic strength. The higher density of the ceramic capillary increases the tool life with increase in the number of bonding touchdowns.
Matte Finish

The SPT’s fine matte finish capillaries provide better stitch adhesion between the Au wire and the substrate metallization due to its gripping effect during the ultrasonic wire bonding process. The matte finishing only appears in the capillary tip face (including the face angle and outer radius) while maintaining polished hole and chamfer areas to ensure smoother exit of the wire during looping.

Polished Finish

Polished capillary finishing has this advantage of lesser contamination build-up and consequently, extending its useful life span. SPT’s ultra-precision polishing techniques ensures uniformly smooth surface finish that is desirable for ultra-fine pitch capillary designed for 60µm BPP and below.

Laboratory Measurements Of Capillaries Surface Roughness
Small Precision Tools is today the only semiconductor bonding tooling manufacturer that utilizes ceramic injection molding (CIM) process to manufacture capillaries for wire bonding application. This special process offers a high degree of reproducibility of complex ceramics part with diverse geometry, different profiles, and undercuts in a single operation of CIM.

The ceramic injection molding is very suitable for high volume production of complex design with tight tolerances like bonding capillaries. It is an effective way of manufacturing complex precision components with the highest degree of repeatability, and reproducibility.

**Basics of Ceramic Injection Molding (CIM)**

Small Precision Tools has the capability to form small, precision, complex parts by injection molding combined with the unique advantages that sintering offers to select material properties.

**The Process**

Small Precision Tools’ injection molding process is a combination of powder, injection molding, and sintering technologies. To obtain the necessary chemical and physical properties, powders are selected by size and shape and complemented with additives. Every particle of the powder is coated with binder components, which transport the powder for molding and gives the final form rigidity.

The binder is removed by evaporation and exothermic reaction, leaving only a small fraction behind. The formed part, depending on the powder used, is then sintered in an oxidizing or reducing atmosphere, or in a high vacuum at temperatures of up to 2400° C.

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**Block Diagram of state-of-the art- Ceramic Injection Molding (CIM) for Capillary**

1. Materials Preparation
2. Powder Mixing
3. Ceramic Injection Molding
4. Sintering Process
5. Finishing

- Capillary Design using Autocad
- Master Tooling & Mold Preparation
The Advantage

Small Precision Tools’ injection molding process offers a high degree of reproducibility. Complex parts in ceramic and metals can be shaped in one operation with diverse geometry, threads, different profiles, undercuts, sharp edges, and different wall thickness.

Injection molding should be considered where conventional machining methods are too expensive, or where the designer can combine two or more parts into a more complex one.

The Application Horizon

Today, the Small Precision Tools’ injection molding process is applied in the instrumentation, textile, automobile, printing, electronic assembly, communications, aerospace, optical, medical, dental and chemical industries. Cost effective applications are found in relatively small parts demanding complex machining operations, and where volume production requires a large investment in machine tools.
A wire bond process optimization is essential for bonding process stability. The process optimization defines a process parameter window for ball and wedge bond quality control.

The following is a basic procedure for wire bond process optimization:

1. Define ball and wedge bond specifications to be used as target response in optimizing a given application.
   - Ball Bond Specification: Upper Specification Limit (USL), Lower Specification Limit (LSL) and average value of deformed ball height, ball diameter and shear strength.
   - Wedge Bond Specification: Lower Specification Limit (LSL), average value and mode of stitch pull strength.

2. Free Air Ball Optimization - Based on ball bond diameter and height requirement, compute for the equivalent free air ball volume in terms of free air ball diameter. This will be used as a target reference for optimizing EFO parameter. Consistency of the target free air ball is the main response to be considered.

3. Define initial working machine parameters to be used as a starting point for optimization. This is normally given by the wire bonder manufacturer or can be based on an existing similar application.

4. Ball Bond and Wedge Bond Optimization
   Response Surface Methodology (RSM), using Central Composite Design (CCD), generate a Design of Experiment (DOE) run matrix using the available working parameter range.

5. Determination of Process Window
   With the aid of a graphical 3D Contour Plot, define the optimized parameter window based on the target response specification.

6. Validation Run - Using the optimized parameters, perform another run to validate the long-term stability of the process. Acquiring a larger sample size, standard deviation and CpK are the responses to be verified.

Below is a typical contour plot result of ball bond optimization using CCD with contour plot. Take note that the 2 parameters, bond force and bond power had been previously identified in the earlier part of the DOE as significant to ball bond response with interaction. Statistical software equipped with experimental design module is available to generate this task.

Based on the Ball Shear Stress Counter Plot, an optimized parameter window is determined in the region of BF(330-370) and BP(12.5-13.5). Other responses, ball diameter and ball height can be combined by overlaying into this graph.
RELIABILITY: DIFFERENT MODES OF BALL SHEAR TEST

Shear Mode 1 - Ball Lift
Full Ball detached with no intermetallics formed

Shear Mode 2 - Aluminum Shear
Full Ball detached with intermetallics

Shear Mode 3 - Bond Shear (Intermetallics sheared)
Interfacial contact ball bond weld area sheared

Shear Mode 4 - Ball Shear (Au only)
Interfacial contact ball bond weld area intact

Shear Mode 5 - Bond Pad Lift
Pad Metalization separates from underlying surface

Shear Mode 6 - Cratering
Bonding Pad lifts, taking portions of underlying substrate material

Shear Mode 7 - Wire Shear (Set-up error)
Minor fragments of ball attached to wire
The area of the bond pad directly affects the effective ball shear readings taken from the bonded units. Considering the ultra-fine pitch application, one can expect much lower set of ball shear readings for 80µm bond pad size as compared with the standard devices greater than 125µm. The maximum value the mashed ball diameter (MBD) can go, is much dependent on the area of the bond pad. Typically, the MBD is less than 5µm to 10µm of the bond pad size opening depending upon the amount of free-air ball and the capillary tip design used. However, the effective ball contact area is described as ball contact diameter (BCD), which is less than the diameter of the MBD - the area where the actual intermetallic formation exist between the bonded ball and the bond pad surface.

Since the Ball Shear Readings (BSR) will be obviously low as the area of contact decreases, it is important to consider the normalized BSR instead or it is referred to as the Ball Shear Stress (BSS) measured in N/mm². The formula to use is:

\[ \text{Ball Shear Stress} = \frac{\text{BSR}}{\frac{\pi \cdot \text{BCD}^2}{4}} \]

Other factors of consideration, which directly affect the ball shear readings, are the following:

- The manner the ball is sheared by the tool with respect to the ball height- typically set at 3 to 5µm range- from the bond pad surface.
- The tip size of the ball shear tool must not interfere with the adjacent bonds-considering the bond pad pitch- during the actual testing.
- Ball shear tester equipment must be free from any influence of vibration in its surroundings.
- The ball shear tool speed setting is recommended at 200µm/sec.
Stitch Bond - A Major Issue

The real challenge in the ultra-fine pitch bonding is the issue of stitch bond formation. The application may it be for substrate or leaded - is basically dictated by the closeness of the bond pad pitch. Consequently, the capillary tip geometry which has a direct influence to the stitch length formation is also reduced proportional to the given bond pad pitch. It is equally tougher to bond a stitch than to form a consistent mashed ball diameter due to other factors such as purity of the material substrate used, its levelness and uniformity, temperature, rigidity of the clamping system, etc… Issues on missing wire or loose tail problems specifically for smaller T < 100µm after the formation of the stitch has to be further investigated.

The Stitch Pull Test Factor

The wire bond pull testing has been an acceptable method in the semiconductor industry to determine the bond quality in terms of pull strengths typically expressed in grams. Generally, the bonded wires are pulled at the highest loop and the readings are taken. However, this method does not prove to be effective due of the nature of application wherein low loop and long wires are used. This has led into some misleading pull test results due to the differences in bonded wire lead lengths.

One practical application of the pull test is to determine the actual break load of wire and its mode of failure closer to the stitch as possible. This means that the pull tester hook must be placed in such a way that it would not interfere with the other wires and then the wires are pulled. The actual gram gauge reading and more importantly, the mode of failure is then taken. In some cases, even if the wires were pulled closer to the stitch, the wire still breaks at the neck. This indicates that the stitch is stronger than the ball side.

The challenge here is how close the hook can be positioned perpendicular to the stitch being pulled, considering the wire diameter of the hook, and how it is being pulled. The gram gauge readings, mode of failure, and the residual of the tail left after its has been pulled. Most importantly, there must be no lifted stitch. Visual appearance of the stitch is also essential to detect if there is a serious cut stitch or tearing problem. Potentially, this would give lower stitch pull readings.
INNOVATIVE CAPILLARY DESIGNS

In Tandem With Today’s Package Challenges

With the rapid changes in the assembly and packaging technology requirements, new packaging solutions are being introduced in response to the demand for smaller, thinner, lighter and faster electronic products. The introduction of ultra-fine pitch, stacked die, multi-tier, low-k and fine-pitch copper wire bonding has again posed new challenges for the wire bonding process. In compliant with these new bonding requirements, SPT has developed a wide range of new capillary designs - Stitch Integrator (SI), Programmed Intelligence (PI) DFX and Infinity capillary to enhance the bonding performance.

Enhanced Stitch Bondability - Stitch Integrator (SI) Capillary

The SI capillary has been developed to enhance the stitch bondability with better coupling effect between the capillary and the wire. Applicable for copper wire, 2N9 gold wire, insulated wire and challenging substrates.

Advanced Bonding Application - Programmed Intelligence (PI) Capillary

Designed for advanced bonding application, such as low-k, stacked die, ultra-fine pitch wire bonding with better ultrasonic transmission.

Enhanced Ball Bondability - DFX Capillary

The DFX capillary concept utilized a smaller chamfer angle to contain the free air ball inside the chamfer, thus resulting in a smaller mashed ball diameter. Applicable for ultra-fine pitch bonding.

Extended Tool Life - Infinity Capillary

SPT proprietary process developed to extend the bonding tool life by at least 3 times its current limit. Applicable for all types of lead frame and substrate base material.

Depending on the specific bonding application, these capillary features can also be integrated together as a total bonding solution for the most challenging applications. Consult with your local SPT sales contact for the optimum capillary design.
As we are aggressively pursuing new technologies to improve the performance of packages and product miniaturization, the current problems associated with wire bonding remains. Bonding issues due to NSOP, NSOL, pad peeling have constantly been a nightmare for wire bond engineers. These issues became more severe with the pressure to reduce the cost of products. The migration of Au to Cu wire for better product performance and cost saving has further increased the difficulties of achieving a reliable stitch bond.

Although it is commonly known that the stitch bond reliability can be improved by increasing the tip diameter and FA/OR optimization of the capillary profile, the limitation lies with fine-pitch and ultra-fine pitch bonding. The restriction with the bond pad pitch limits the flexibility of using a larger tip diameter. The use of a smaller FA helps to improve the stitch bondability but at the expense of lower stitch pull reading and possibly, shorter tool life. Working within these limitations, a new capillary design is today developed by SPT to improve the stitch bondability.

Small Precision Tools (SPT) Stitch Integrator capillary has been developed with the objective to improve the bondability of the stitch bond through better coupling effect between the bonding tool and the wire during bonding. Through extensive studies and optimizations, the Stitch Integrator capillary has been derived and has proven to enhance the stitch bondability as compared to non-SI capillary design in many field applications.

Features:

- Improved stitch integration with the substrate with better ultrasonic energy transfer.
- Enhanced coupling effect between the capillary and the wire with better stitch bondability.
- Higher MTBA with fewer machine down time and higher product output.

Depending on the specific bonding application, the Stitch Integrator capillary can be used together with any existing design feature, such as the DFX (for small ball large wire bonding), Infinity (for extended tool life), etc. Indeed, the Stitch Integrator capillary has proven to be a new revolution for enhanced stitch bondability.
The advancement in bonding technology and the market demand for faster, smaller and better product, again poses new challenges for the wire bonding process. The transition from fine-pitch (FP) to ultra fine-pitch (UFP) volume production, and the emergence of stacked die, multi-tier and low-K bonding has increased the level of difficulties in the wire bonding process with more yield loss due to lifted ball, wire short, etc.

In compliance with these new bonding requirements, SPT has embarked on an extensive study to develop a new generation, high-performance capillary. Designed with advanced process diagnostic tools, the new capillary design, known as PI (Programmed Intelligence) capillary has been extensively tested in a variety of wire bonders and packages. In all tests, the PI capillary has demonstrated superior bonding performance with good repeatability and portability using a wide range of bonding platforms.

Features:

- Superior bonding performance with good repeatability and portability for a broad range of complex application.
- More responsive to the bonding parameters, producing better bonding integrity.
- Applicable for fine-pitch, ultra-fine pitch, ultra low loop, CSP, low-k and stacked die bonding.

Depending on the specific bonding application, the PI design can be used together with any existing design feature, such as the SI (for enhanced stitch bondability), DFX (for fine-pitch and ultra fine pitch) and Infinity (for extended tool life), etc.
Typically, as Ultra-Fine Pitch Bonding goes below 50µm BPP, the given BPP and bond pad opening (BPO) requires a much smaller wire diameter (WD) of 20µm and below. While this offers the advantage of cost reduction and the use of standard capillary design, wire sweep problems surfaced during the molding process. Most reverted back to using larger wire diameter of 23µm.

Due to the dimensional constraint on the hole and chamfer diameter of the capillary, SPT developed a unique capillary design, the 'Dfx' capillary specifically targeting to contain the gold squashed out during bonding. This design concept utilized a smaller chamfer angle (CA) to contain the Free Air Ball (FAB) inside the chamfer, thus resulting in a smaller mashed ball diameter (MBD) as shown below.

Features:

- 40% of FAB contained within the inner chamfer thus resulting in a smaller bonded ball with minimal squashed out.

- Possibility of using larger wire size for better wire control.

- Improved bondability with better ball shear strength.

The design of the 'Dfx' capillary was conceptualized for controlled ball deformation during bonding. Based on lab evaluation and data from customer’s production, the ‘Dfx’ capillary has proven to improve the ball shear reading, especially for BGA device, hence reducing the occurrence of non-sticking on pad during bonding.
In wire bonding, load-up on the capillary face is inevitable as the bond touchdown increases. This is mainly due to the scrubbing action of the capillary from the ultrasonic energy applied in the process of making bonds. As the load-up amount increases, bond quality is affected. The useful life of the capillary can be defined as the maximum bond number before the bond quality produced by the capillary is deemed unacceptable. Depending on the types of substrate and bonding condition, the tool life of the capillary can vary from a few hundred thousand bonds to more than 1 million bonds.

An SPT proprietary process has been developed to extend the bonding tool life by at least 3 times its current limit, utilizing state-of-art controlled high purity process that enhances the sub-surface properties of the ceramic based material. Through various in-house testing and user evaluations, the Infinity capillary has proven to exceed the current tool life by at least 3 times the standard.

**Features:**

- Long life capillary at least 3x of its original.
- No change in bonding parameters
- Higher mean time before failure (MTBF)
- Less bonder downtime; higher production output
The continuous miniaturization of packaging footprint having a tight bond pad pitch of IC has led to an increase in the demand of ultra-fine pitch wire bonding ceramic capillary with smaller tip diameter profile. Advancement in the wire bonding technology has aggressively changed the definition of ultra-fine pitch from 60µm BPP some years back, to 50µm BPP and below today.

The transition from fine-pitch to ultra-fine pitch volume production has increased the level of difficulties in the wire bonding process. As the bond pad opening becomes smaller for ultra-fine pitch devices, the challenge is to be able to contain the miniature ball bond into the tiny pad opening on the device with good bondability.

The innovative approach of utilizing the PI capillary design has shown significant improvement in the ultrasonic response. The PI capillary has shown to be more responsive to the bonding parameter with good bondability, repeatability and portability using a wide range of bonding platform.

To further control the deformed ball size within the bond pad opening, SPT incorporates the DFX capillary design specifically targeting to contain the gold squashed out during bonding. Based on bonding test conducted in a variety of wire bonders and packages, the DFX capillary has shown to produce superior ball size control with good ball shear performance.

The combination of the PI-DFX capillary design offers the ultimate design features for ultra-fine pitch gold wire bonding.

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<th>Bond Pad Pitch µm</th>
<th>Useable Wire Diameter µm</th>
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<th>FA °</th>
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Note: Refer to Page 40 for detailed dimension call-out
POPULAR CAPILLARY DESIGNS ≤ 50µm BOND PAD PITCH

**50µm BPP**
- MBD Ave: 38.2µm
- WD: 23µm
- for WD=23µm: PI-28063-331F-ZP34T
- BSR Ave: 13.0gf
- WPT: >3gf

**45µm BPP**
- MBD Ave: 35.1µm
- WD: 20µm
- for WD=20µm: PI-25063-301F-ZP34T
- for WD=18µm: PI-23063-281F-ZP34T
- BSR Ave: 9.8gf
- WPT: >2.5gf

**40µm BPP**
- MBD Ave: 31.4µm
- WD: 18µm
- for WD=18µm: PI-22050-271F-ZP34T
- BSR Ave: 8.7gf
- WPT: >2gf

**35µm BPP**
- MBD Ave: 27.3µm
- WD: 15µm
- for WD=15µm: PI-19045-231F-ZP34T
- BSR Ave: 8.4gf
- WPT: >1.8gf

**30µm BPP**
- MBD Ave: 23.8µm
- WD: 12.5µm
- for WD=12.5µm: PI-15038-181F-ZP34T
- BSR Ave: 6.0gf
- WPT: >1.5gf
In the past, wire bonding for the various integrated circuit (IC) packaging used to be in the non-fine pitch region with the number of I/O of 100 wires and below. Such interconnect can be performed with standard capillary without much difficulty. However, as the number of I/O increases for more complex devices, fine pitch bonding often becomes necessary. With the reduction in the bond pad pitch, the tip diameter together with other critical geometry of the capillary had to be reduced significantly to prevent any interference to the adjacent wires during bonding. In addition, the requirement for smaller ball size due to the smaller bond pad opening has further increase the level of difficulties during bonding.

Generally, fine pitch bonding for current applications are commonly done on high frequency bonder, which produces smaller displacement but at higher cycle rate as compared to conventional bonder. Depending on the ultrasonic power setting on the bonder, the ultrasonic energy is transmitted directly from the transducer to the capillary to create the necessary ball deformation. Unlike bonding on non-fine pitch devices, which can accommodate a wide range of ball size variations due to the larger pad opening, bonding on fine pitch devices required the ball size to be controlled within a much tighter tolerance. Given the tight bonding process requirements, the relevance of having a precise and accurate capillary tool geometry has become one of the significant influencing factors for the success of establishing a robust wire bonding process.

The **Slimline BottleNeck (SBN) capillary** design is intended for fine-pitch application for bond pad pitch (BPP) 125um up to as fine as 90um. For 80um BPP and below, the **Pi capillary** design is recommended.
1. Standard Main Taper Angle (MTA) is 30° for SBN tip style and 20° for PI tip style.

2. Standard Bottleneck Angle (BNA) is 10°.

3. Standard finishing is polished. Matte finish option is also available for both AZ and/or C materials.

4. For 'T' > 165µm, standard UTS/UTF tolerance will be applied.

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### Dimensional Features

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<th>Dimensional Features</th>
<th>BPP &gt; 90µm</th>
<th>BPP ≤ 90µm</th>
<th>BPP ≤ 70µm</th>
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<td>T ≤ 110µm</td>
<td>T ≤ 90µm</td>
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<td>Hole Diameter (H)</td>
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<td>+2/-1µm</td>
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<td>Chamfer Diameter (CD)</td>
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<td>± 2µm</td>
<td>± 2/-1µm</td>
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<td>± 2µm</td>
<td>± 2/-1µm</td>
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<td>Outside Radius (OR)</td>
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<td>± 5µm</td>
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<td>Tip Diameter (T)</td>
<td>± 5µm</td>
<td>± 5µm</td>
<td>± 3µm</td>
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</tbody>
</table>

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Note: Refer to Page 40 for detailed dimension call-out.
POPULAR CAPILLARY DESIGNS ≥ 60µm BOND PAD PITCH

60µm BPP
MBD Ave: 46.5µm  BSR Ave: 16.5gf
WD: 25µm        WPT: >4.0gf
for WD=25µm: PI-30080-385F-ZP34T
for WD=23µm: PI-28080-355F-ZP34T

70µm BPP
MBD Ave: 56.0µm  BSR Ave: 28.2gf
WD: 25µm        WPT: >4.0gf
for WD=25µm: PI-33090-435F-ZP34T
for WD=23µm: PI-30090-415F-ZP34T

80µm BPP
MBD Ave: 60.0µm  BSR Ave: 33.0gf
WD: 25µm        WPT: >4.0gf
for WD=25µm: PI-35100-485F-ZP34T

90µm BPP
MBD Ave: 68.0µm  BSR Ave: 36.0gf
WD: 30µm        WPT: >6.0gf
for WD=30µm: SBN-38110-535F-ZP36T
for WD=25µm: SBN-35110-535F-ZP36T

100µm BPP
MBD Ave: 73.0µm  BSR Ave: 50.0gf
WD: 30µm        WPT: >6gf
for WD=30µm: SBN-38130-585F-ZP36T
for WD=25µm: SBN-35130-535F-ZP36T
HOW TO ORDER

Capillary Series
- SI
- PI
- DFX
- SBN

Hole Size

Tip Diameter

Chamfer Diameter

Chamfer Angle
- 90 deg: 5
- 120 deg: 8

Face Angle
- 0 deg: A
- 4 deg: C
- 8 deg: E
- 11 deg: F

Material
- Z: Zirconia composite
- C: High Density Ceramic

Finishing
- Matte: M
- Polish: P
- SI Finishing: B

Length
- L: 1
- XL: 3
- XXL: 5
- 16mm: 7
- 19mm: 9

Main Taper Angle
- 20 deg: 4
- 30 deg: 6
- 50 deg: 8

Bottle Neck Angle
- 10 deg: T

For SI Series Only
- PI capillary design: P
- SBN capillary design: S

Infinity Design
The popular UT series for standard non-fine pitch in-line wire bonding application are available in different face angles of 4° (UTF), 8° (UTS), and 11° (UTE), and a standard 90° chamfer angle with options for 70° and 120°. The UT series is commonly used for discrete packages that don't require bottleneck capillary design with its tip diameter ranging from 140µm to 710µm with a standard 30° main taper angle (MTA). Optional 20° MTA is also available. This is a proven capillary, which is designed for higher ball shear, and stitch pull strength readings - mostly for low frequency (<100KHz) wire bonder.

**Material + Finish**
- **C** = High density, Fine Grain Ceramic “Polish”
- **CM** = High density, Fine Grain Ceramic “Matte”

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<th>Material + Finish</th>
<th>Tool Diameter (TD)</th>
<th>Tool Length (TL)</th>
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<td>C = High density, Fine Grain Ceramic “Polish”</td>
<td>1/16 = 1.587 mm / .0625”</td>
<td>L = 9.53 mm / .375”</td>
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<td>CM = High density, Fine Grain Ceramic “Matte”</td>
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<td>XL = 11.10 mm / .437”</td>
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<td></td>
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<td>XXL = 12.00 mm / .470”</td>
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<td>16mm = .630”</td>
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<td>19mm = .750”</td>
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**How To Order**

**SPECIFY**: Tip Style - Material+Finish - Tool Diameter - Tool Length

(Specify any special modifications required such as Main Taper Angle, MTA)

**EXAMPLE**: UTF - 38HG - C - 1/16 XL
UTE70 - 33IG - CM - 1/16 L
UTS120 - 43HH - C - 1/16 XL 20MTA
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<td>UTF - 68N</td>
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<td>127 / .0050</td>
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<td>300 / .0118</td>
<td>51 / .0020</td>
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<td>UTF - 75Q</td>
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<td>30.0 / .0120</td>
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<td>64 / .0250</td>
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<td>UTF - 84U</td>
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<td>28.0 / .0110</td>
<td>140 / .0055</td>
<td>75 / .0300</td>
<td>360 / .0142</td>
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<tr>
<td>UTF - 90U</td>
<td>90 / .035</td>
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<td>430 / .1069</td>
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<td>127 / .050</td>
<td>33.0 / .0130</td>
<td>193 / .0076</td>
<td>75 / .0300</td>
<td>410 / .1061</td>
<td>100 / .0039</td>
</tr>
</tbody>
</table>
The CSA series has a standard 0° face angle (FA) and a relatively large outer radius (OR) design. The design combination of the FA and OR is used to provide an excellent stitch transition. It is available in matte or polished tip surface finishing. The matte option has a finely textured surface that helps to reduce the slip effect between the wire-tool interface, ensuring consistent transfer of ultrasonic energy to wire-substrate interface. The textured surface also decreases wire smashed out by reducing the material flow for bonding metallization that are soft and/ or rough.

### Material + Finish

<table>
<thead>
<tr>
<th>Material</th>
<th>Finish</th>
<th>Tool Diameter (TD)</th>
<th>Tool Length (TL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>High density, Fine Grain Ceramic “Polish”</td>
<td>1/16 = 1.587 mm / .0625”</td>
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<tr>
<td>CM</td>
<td>High density, Fine Grain Ceramic “Matte”</td>
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<td>L = 9.53 mm / .375”</td>
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### Tool Diameter (TD)

<table>
<thead>
<tr>
<th>Size</th>
<th>Value</th>
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<tbody>
<tr>
<td>16mm</td>
<td>.630”</td>
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<tr>
<td>19mm</td>
<td>.750”</td>
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<table>
<thead>
<tr>
<th>Size</th>
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<tbody>
<tr>
<td>XL</td>
<td>11.10 mm / .437”</td>
</tr>
<tr>
<td>XXL</td>
<td>12.00 mm / .470”</td>
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<tr>
<td>16mm</td>
<td>.630”</td>
</tr>
<tr>
<td>19mm</td>
<td>.750”</td>
</tr>
</tbody>
</table>

### How To Order

SPECIFY: Tip Style - Material+Finish - Tool Diameter - Tool Length

(Specify any special modifications required such as Main Taper Angle, MTA)

EXAMPLE: CSA - 46JH - CM - 1/16 XL
CSA - 46JH - C - 1/16 XL 20MTA
<table>
<thead>
<tr>
<th>Tip Style</th>
<th>Hole Diameter H µm/in ±3/.001</th>
<th>Inside Chamfer IC µm/in (Ref)</th>
<th>Chamfer Diameter CD µm/in ±5/.002</th>
<th>Outside Radius OR µm/in ±3/.003</th>
<th>Tip Diameter T µm/in ±8/.003</th>
<th>Useable Wire Diameter µm/in</th>
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<tbody>
<tr>
<td>CSA - 25DB</td>
<td>25 / .0010 8.0 / .00030</td>
<td>41 / .0016</td>
<td>30 / .0012</td>
<td>120 / .0047</td>
<td>18 / .0007</td>
<td></td>
</tr>
<tr>
<td>CSA - 33ES</td>
<td>33 / .0013 8.0 / .00030</td>
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<td>30 / .0012</td>
<td>130 / .0051</td>
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<tr>
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<td>25 / .0010</td>
<td></td>
</tr>
<tr>
<td>CSA - 43EE</td>
<td>43 / .0017 8.0 / .00030</td>
<td>58 / .0023</td>
<td>30 / .0012</td>
<td>130 / .0051</td>
<td>30 / .0012</td>
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<tr>
<td>CSA - 51NH</td>
<td>51 / .0020 11.5 / .00045</td>
<td>74 / .0029</td>
<td>51 / .0020</td>
<td>190 / .0075</td>
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<tr>
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<td>64 / .0025 11.0 / .00043</td>
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<td>225 / .0089</td>
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<td>200 / .0079</td>
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<tr>
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<tr>
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<tr>
<td>CSA - 46JJ</td>
<td>46 / .0018 20.0 / .00079</td>
<td>86 / .0034</td>
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<tr>
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<td>64 / .0025 11.0 / .00043</td>
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<td>140 / .0055</td>
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<td>64 / .0025</td>
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</table>
### Tip Style
- **UT** - Standard capillary with Face Angle for non-Fine Pitch application
- **CSA** - Standard capillary with a 0° Face Angle for non-Fine Pitch application

### Face Angle
- Z - 0°
- F - 4°
- S - 8°
- E - 11°

### Chamfer Angle
- Standard - 90° (no need to specify)
- Specify if non-standard

### Hole Size

<table>
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<th>Description</th>
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<td>R = 360 µm (.0142&quot;)</td>
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<td>S = 410 µm (.0161&quot;)</td>
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<td>T = 420 µm (.0165&quot;)</td>
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<td></td>
<td>U = 430 µm (.0169&quot;)</td>
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<td></td>
<td>V = 710 µm (.0279&quot;)</td>
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### Tip Diameter

<table>
<thead>
<tr>
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<th>Description</th>
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<tbody>
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<td>35 µm (.0014&quot;)</td>
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<td>F = 64 µm (.0025&quot;)</td>
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<td>L = 100 µm (.0039&quot;)</td>
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<tr>
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<td>M = 114 µm (.0045&quot;)</td>
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<tr>
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<tr>
<td>178 µm (.0070&quot;)</td>
<td>T = 199 µm (.0078&quot;)</td>
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### Chamfer Diameter

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Description</th>
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<tbody>
<tr>
<td>25 µm (.0010&quot;)</td>
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<td>38 µm (.0015&quot;)</td>
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<td>46 µm (.0018&quot;)</td>
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<td>51 µm (.0020&quot;)</td>
<td>J = 86 µm (.0034&quot;)</td>
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<td>56 µm (.0022&quot;)</td>
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</tr>
<tr>
<td>178 µm (.0070&quot;)</td>
<td>T = 199 µm (.0078&quot;)</td>
</tr>
</tbody>
</table>

### Material
- **C** - High Density Fine Grain Ceramic 99.99% Al₂O₃

### Finish
- **Polish** - No need to specify
- **Matte (M)** - Must be specified

### Tool Diameter
- Standard - 1.587mm (.0625")

### Tool Length
- **L** = 9.53 mm (.375")
- **XL** = 11.10 mm (.437")
- **XXL** = 12.0 mm (.470")

### Main Taper Angle (MTA)
- **UT and CSA series** - Standard 30° (No need to specify)
- **Others** - 20° (Must be specified)
COPPER WIRE BONDING

Copper (Cu) wire bonding is not new in the industry. 1.5mil and 2mil Cu wire has been in volume production for many years mainly for power devices. Generally, Cu wire has higher thermal and electrical conductivity with lower power loss and higher current flow as compared to Au wire. These properties are important for enhanced device performance and reliability. With a cost saving of more than 80% as compared to Au wire, Cu wire has emerged as a growing choice for fine-pitch and ultra-fine pitch bonding.

Today, most of the wire bonders is capable of bonding fine pitch Cu wire with very minimal upgrading kit. Most of the upgrading kit consists of software and a nozzle mount near to the EFO with forming gas (95%N2, 5%H2) to prevent FAB oxidation. However, the stitch bond performance still remains to be optimized. To improve stitch bondability, higher bonding parameters has to be used, causing heavy cap imprint and potential short tail or wire open issues. Although the wire supplier has came up with high purity Cu wire with purity at 99.99%, intermittent wire open and short tail issues remain to be solved.

The challenge is to be able to improve the stitch bondability for Cu wire. The enhanced coupling effect between the SI capillary and the wire has proven to improve the bondability of the stitch bond with minimum interruption to the bonder.

<table>
<thead>
<tr>
<th>Bond Pad Pitch µm</th>
<th>Useable Wire Diameter µm</th>
<th>H µm</th>
<th>CD µm</th>
<th>FA °</th>
<th>T µm</th>
<th>Recommended SPT Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>30</td>
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</table>
The process for low-k device bonding is very sensitive especially for ultra-fine-pitch bonding. In fact, the most challenging problem with low-k wire bonding is ball bond reliability. A polymer-induced bonding problem occurs when the bond pad is small. If the polymer is soft or heated above its Glass Transition Temperature (Tg) during thermosonic bonding, the small bond pad can partially sink into the polymer during application of bonding force. This lowers the effective bond force after the capillary contacts the pad, and therefore higher ultrasonic energy is required. ‘Cupping’ or sinking can damage low-k diffusion barriers and results in failure.

Problems associated with low-k wire bonding are as follows (typical failure reject criteria):

- Non-sticking on bond pad
- Metal peeling / de-lamination
- Damaged / fractured bond pad
- Effects of probe marks
- Poor bond shear strength

Although wire bonding has been a well-established technology for many years, the bonding tool design becomes more complex as the process of low-k devices is very sensitive for wire bonding. Stability of ultrasonic energy transmission and lower ultrasonic-generator power are needed to prevent pad damage. From the various evaluations and analysis conducted, the PI capillary design showed the best attributes in terms of efficiency of ultrasonic energy transfer and better bond integrity. Together with the DFX feature, the PI-DFX combination has proven to reduce pad peeling and improved bond integrity with higher percentage of inter-metallic compound in the bond interface.

### Table: Bond Pad Pitch and Part Numbers

<table>
<thead>
<tr>
<th>Bond Pad Pitch (µm)</th>
<th>Useable Wire Diameter (µm)</th>
<th>H (µm)</th>
<th>CD (µm)</th>
<th>FA (°)</th>
<th>T (µm)</th>
<th>Recommended SPT Part Number</th>
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<tr>
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<td>25</td>
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<td>43</td>
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<tr>
<td></td>
<td>23</td>
<td>28</td>
<td>35</td>
<td>11</td>
<td>80</td>
<td>PI-28080-353F-ZP34T</td>
</tr>
<tr>
<td>50</td>
<td>23</td>
<td>28</td>
<td>33</td>
<td>11</td>
<td>63</td>
<td>PI-28063-331F-ZP34T</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>11</td>
<td>63</td>
<td>PI-25063-301F-ZP34T</td>
</tr>
<tr>
<td>45</td>
<td>20</td>
<td>24</td>
<td>29</td>
<td>11</td>
<td>55</td>
<td>PI-24055-291F-ZP34T</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>22</td>
<td>28</td>
<td>11</td>
<td>55</td>
<td>PI-22055-281F-ZP34T</td>
</tr>
</tbody>
</table>
As the popularity of mobile phones, digital cameras, personal digital assistant, etc drives the move towards smaller geometry chips, new packaging method are to be developed to integrate highly complex chips into the smallest possible space.

The miniaturization of such products was made possible by the application of stacked-die Chip Scale Package (CSP) packaging technology. Indeed, the demand for small form factor packages, increased functionality in the same area, and low cost are the product requirements for stacked-die CSP's. Inside the stacked-die CSP's, it contains 2 or more dice, stacked over each other. Wire bonding is most commonly used for interconnection.

Stacked die packaging is the most versatile wire bonded package among all other packages. It comes in different design configurations - from pyramid stacking to overhang stacking, from standard bonding to low loop and reverse bonding. Given the complexity of the chip configurations, capillary design needs to be optimized for each particular bonding configuration.

- **Pyramid stacking**
  
  Dimensional selection as per standard capillary selection guide. However, as more and more chips were stacked, the wire length for the upper chip increases. Wire sway could be a major issue. PI Capillary design has been used extensively to minimize wire sway issue, especially for long loop application.

- **Overhang and same die size stacking**
  
  Die deflection due to the impact force during bonding, especially at the corners of the die can result in NSOP. Normally parameter optimization or re-grouping of the corner wires is necessary. Reverse bond using ball stitch on ball technique is normally used to achieve the low loop height requirement.

- It should be noted that stacked die bonding represents one of the most complex bonding in the wire bond process. Within one package, different bonding techniques using forward bonding, reverse bonding, multi-tier bonding together with the new loop trajectory can be performed. Again, each type of bonding has its own uniqueness and need to be considered separately when selecting the optimum capillary design.

<table>
<thead>
<tr>
<th>Bond Pad Pitch (µm)</th>
<th>Useable Wire Diameter (µm)</th>
<th>H (µm)</th>
<th>CD (µm)</th>
<th>FA °</th>
<th>T (µm)</th>
<th>Recommended SPT Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>25</td>
<td>35</td>
<td>51</td>
<td>11</td>
<td>100</td>
<td>PI-35100-515F-ZP34T</td>
</tr>
<tr>
<td>70</td>
<td>25</td>
<td>33</td>
<td>43</td>
<td>11</td>
<td>90</td>
<td>PI-33090-435F-ZP34T</td>
</tr>
<tr>
<td>60</td>
<td>23</td>
<td>30</td>
<td>38</td>
<td>11</td>
<td>80</td>
<td>PI-30080-385F-ZP34T</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>11</td>
<td>63</td>
<td>PI-25063-301F-ZP34T</td>
</tr>
</tbody>
</table>
BALL STITCH ON BALL (BSOB) BONDING

For extremely low loop profile of about <50um wire bonding application, the ball stitch on ball (BSB) is an alternative choice. The process is a two-step one cycle; the first is to form a stud ball bump into the bond pad; and then a reverse bonding (the ball bond is bonded into the lead frame, and stitch on top of the ball bump). The general design rule for the capillary selection for BSOB bonding follows the basic wire bonding fundamentals. 8° face angle is recommended to improve the stitch bondability.

<table>
<thead>
<tr>
<th>Bond Pad Pitch µm</th>
<th>Useable Wire Diameter µm</th>
<th>H µm</th>
<th>CD µm</th>
<th>FA °</th>
<th>T µm</th>
<th>Recommended SPT Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>25</td>
<td>35</td>
<td>58</td>
<td>8</td>
<td>130</td>
<td>SBN-35130-585E-ZP36T</td>
</tr>
<tr>
<td>90</td>
<td>25</td>
<td>35</td>
<td>53</td>
<td>8</td>
<td>120</td>
<td>SBN-35120-535E-ZP36T</td>
</tr>
<tr>
<td>80</td>
<td>25</td>
<td>35</td>
<td>51</td>
<td>8</td>
<td>100</td>
<td>PI-35100-515E-ZP34T</td>
</tr>
<tr>
<td>70</td>
<td>25</td>
<td>33</td>
<td>43</td>
<td>8</td>
<td>90</td>
<td>PI-33090-435E-ZP34T</td>
</tr>
<tr>
<td>60</td>
<td>25</td>
<td>30</td>
<td>38</td>
<td>8</td>
<td>80</td>
<td>PI-30080-385E-ZP34T</td>
</tr>
</tbody>
</table>
STUD BALL BUMPING (SBB)

With continuous die size shrinkage and finer bond pad pitches of less than 60um, this solder bumping process is expected to be the future option for packaging technology miniaturization. For CSP flip chip application, solder bumping of wafer are done either by electroplating method to form the 63Sn-37Pb solder balls, and the other method is by gold (Au) ball bonds formed on the aluminum bond pad (Al) by a conventional wire bonder. Special designed capillary is needed to meet the different bond pad pitches. The general design rule on the desired mashed ball (MBD) given the bond pad opening still applies. However, since there is no looping, the capillary with 20 deg main taper angle (MTA) is one of the design features.

<table>
<thead>
<tr>
<th>Bond Pad Pitch µm</th>
<th>Useable Wire Diameter µm</th>
<th>H µm</th>
<th>CD µm</th>
<th>FA °</th>
<th>T µm</th>
<th>Recommended SPT Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>30</td>
<td>35</td>
<td>55</td>
<td>0</td>
<td>130</td>
<td>SBB-35130-558A-ZP34</td>
</tr>
<tr>
<td>90</td>
<td>25</td>
<td>30</td>
<td>53</td>
<td>0</td>
<td>110</td>
<td>SBB-30110-538A-ZP34</td>
</tr>
<tr>
<td>80</td>
<td>25</td>
<td>30</td>
<td>51</td>
<td>0</td>
<td>100</td>
<td>SBB-30100-518A-ZP34</td>
</tr>
<tr>
<td>70</td>
<td>25</td>
<td>30</td>
<td>48</td>
<td>0</td>
<td>90</td>
<td>SBB-30090-488A-ZP34</td>
</tr>
</tbody>
</table>
Capillaries for special deep access types of packaging application are available. The uniqueness of the tip taper design is dependent upon the die and package orientation. These capillaries provide vertical clearance between adjacent high loop profile and die edge.

![VBN taper design](image1)

![Deep access wire bonding](image2)

### Special Taper Designs

**VBN Taper Design**
- Deep access wire bonding

### Design Specifications

1. **ONE SIDE RELIEF (OSR)**
   - Specify VR and SR

2. **DOUBLE SIDE RELIEF (DSR)**
   - Specify VR and DR

3. **90° DOUBLE SIDE RELIEF (90 DSR)**
   - Specify VR and SR

4. **VERTICAL BOTTLENECK STYLE (VBN)**
   - Specify BNH and MD

### Bond Pad Pitch

<table>
<thead>
<tr>
<th>Bond Pad Pitch (µm)</th>
<th>Useable Wire Diameter (µm)</th>
<th>H (µm)</th>
<th>CD (µm)</th>
<th>FA (°)</th>
<th>T (µm)</th>
<th>Recommended SPT Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 140</td>
<td>30</td>
<td>43</td>
<td>74</td>
<td>8</td>
<td>200</td>
<td><strong>UTS-43JH-CM1/16XL</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VBN BNH=1.50mm MD=0.800mm</td>
</tr>
<tr>
<td>&gt; 140</td>
<td>30</td>
<td>38</td>
<td>58</td>
<td>8</td>
<td>150</td>
<td><strong>UTS-38GE-CM1/16XL</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BNH=1780µm VBN MD=450µm</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>38</td>
<td>58</td>
<td>8</td>
<td>100</td>
<td><strong>SBNS-38BE-AZ1/16XL</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OSR BNH=400µm SR=280µm VR=2000µm</td>
</tr>
</tbody>
</table>
How To Order:

**BST - Face Width - Drawing (Options)**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Face Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>BST-0.050</td>
<td>50µm</td>
</tr>
<tr>
<td>BST-0.060</td>
<td>60µm</td>
</tr>
<tr>
<td>BST-0.080</td>
<td>80µm</td>
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<tr>
<td>BST-0.100</td>
<td>100µm</td>
</tr>
<tr>
<td>BST-0.150</td>
<td>150µm</td>
</tr>
</tbody>
</table>

**Note:** Other sizes or design available on request

---

**CAPILLARY UNPLUGGING PROBE**

Capillary unplugging probes offer an easy, economical way to unplug capillaries. No special equipment is required and one size fits all SPT capillaries. Each probe can be used dozens of times.

**Style CUP**

<table>
<thead>
<tr>
<th>How To Order</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CUP - 25PB - L = .750 (standard length)</td>
<td></td>
</tr>
<tr>
<td>CUP - 25PB - L = 1.00 (optional length)</td>
<td></td>
</tr>
</tbody>
</table>

* Capillary Unplugging Probes are packed 25 each in a protective box.
* * Probes also available without Epoxy Ball.
CAPILLARY UNPLUGGING WIRE (CUW)

Capillary unplugging wire offers an easy and economical way to unplug clogged capillary. This is especially useful for engineers during evaluation as the gold ball tends to get clogged in the capillary holes since the optimum process parameters are not defined yet.

The unplugging wire has also proven to be helpful to production operators when they have difficulties threading the wire through the capillary. Instead of changing to a new capillary, the unplugging tool can help to push out gold residues, foreign particles and gold ball out of the hole. This can be done by simply inserting the tip of the unplugging tool from the top of the capillary and gently raises and lowers the wire within the capillary.

**Advantages:**

- Clogged capillaries can easily be unplugged, hence minimize capillary wastage before end of tool life.
- User friendly. Removal of capillary from the transducer is not necessary as the flexible tip of the unplugging tool can be inserted from the top of the capillary as shown.
- Optimize tip configuration to handle a wide ranges of capillary hole size.
- Each unplugging tool can be used more than dozen of times thus saving unnecessary wastage of capillary and production down time.
- Especially useful for ultra fine-pitch capillaries as the capillary hole gets clogged easily due to limited gold wire clearance in the hole.

**How To Order:**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Capillary Hole Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUW-15</td>
<td>15-23µm</td>
</tr>
<tr>
<td>CUW-25</td>
<td>25-33µm</td>
</tr>
<tr>
<td>CUW-35</td>
<td>35-45µm</td>
</tr>
<tr>
<td>CUW-45</td>
<td>45-55µm</td>
</tr>
</tbody>
</table>
OTHER ACCESSORIES FOR WIRE BONDING PROCESS

EFO WANDS

The importance of consistent free air ball (FAB) for fine-pitch (FP) and ultra-fine pitch (UFP) bonding applications has led to the development of new alloy material to improve the performance of the EFO wand. Together with a new proprietary process, consistent EFO sparking effect can be achieved with SPT EFO wands. SPT is capable of making customized EFO wands used on different types of bonder with precise dimensions and accuracy.

When a new EFO wand is first installed on the bonder, inconsistent sparking effect normally occurs, causing inconsistent FAB formation. It was also noticed that the spark, during firing tends to sway to the left or right during the initial sparks. This has the tendency to produce a tilted FAB as shown. This effect is mainly due to the inability of the new EFO to lead the current to flow from the same point.

To eliminate such adverse effect, SPT has introduced a proprietary process whereby new EFO wands are subjected to continuous sparking similar to those seen on the bonder. Such process will ensure that the new EFO wands can achieve its desired performance without having to “season” them, thus causing production delay and yield loss.

This process can be performed for a wide variety of EFO wands used for different types of bonders currently available in the market.

SPT EFO Wands Offer:

- Consistent free air ball formation.
- Consistent ball size control.
- Ball shape uniformity.
- Proprietary process for superior sparking performance.

How To Order

EFO - Model - Option.
Example: EFO - KNS8028

Note: Other standard or custom models available on request
Please refer to opposite page for EFO models
## EFO Wand Models

### ASM
- **ASM0309**
  - For Bonder: AB309
- **ASM0339**
  - For Bonder: AB339
  - Eagle 60
- **ASM339C**
  - For Bonder: AB339
  - Eagle 60
- **ASM339D**
  - For Bonder: iHawk

### K&S
- **KNS1484**
  - For Bonder: 1484
- **KNS1488**
  - For Bonder: 1488
- **KNS1489**
  - For Bonder: 1488
- **KNS8021**
  - For Bonder: 8020
- **KNS8028**
  - For Bonder: 8028
  - Maxum NuTek
- **KNS8098**
  - For Bonder: 8098 Ball Bumper
- **KNS8128**
  - For Bonder: 8028

### SHINKAWA
- **SHK025A**
  - For Bonder: ACB-25
- **SHK0035**
  - For Bonder: SDW-35
- **SHK0200**
  - For Bonder: UTC-200
  - UTC-205
- **SHK0300**
  - For Bonder: UTC-300
- **SHK400A**
  - For Bonder: ACB-400
  - ACB-450
- **SHK1000**
  - For Bonder: UTC-1000
- **SHK2000**
  - For Bonder: UTC-2000

### KAIJO
- **KAJ0118**
  - For Bonder: FB-118
- **KAJ131B**
  - For Bonder: FB-131
- **KAJ137A**
  - For Bonder: FB-137
- **KAJ0170**
  - For Bonder: FB-170
  - FB-180
  - FB-190
- **KAJ1000**
  - For Bonder: FB-1000

### ESEC
- **ESE3000**
  - For Bonder: 3006
  - 3008
  - 3018
  - 3088
- **ESE3100**
  - For Bonder: 3100
- **ESE3101**
  - For Bonder: 3100
  - (Cu + Au Wire)

### DELVOTEC
- **DEL6200**
  - For Bonder: 6200
  - 6210

### RHOM
- **RHMBW01**
  - For Bonder: ZWBC1

### KEC
- **KEC180B**
  - For Bonder: KWB2100

### TOSHIBA
- **TOS0943**
  - For Bonder: HN943
HEATER BLOCKS

SPT’s Heater Block Assembly offers yet another value-added product to further support end-users for their complex bonding application. SPT is capable to fabricate a wide variety of heater block assembly for all types of packages used on any type of wire bonder.

HB SOLUTION FOR QFP SOP MULTI-LEAD PACKAGE

SPT’s “butterfly” design has proven to eliminate the bouncing effect on the lead finger. The “butterfly” design has shown excellent gripping & clamping stability on lead fingers, especially for high pin counts QFP packages.

With SPT’s “butterfly” design, no high temperature tape is required. This has been tested and proven at many customer production sites with superior performance as compared to conventional design.

Advantages:

- Absolute lead finger stability during bonding with the “butterfly” design heater block assembly.
- The “butterfly” heater block assembly can be applied to a wide range of lead frame design for all types of wire bonder.
- Especially useful for FP and UFP high pin count devices.

HB SOLUTION FOR QFN AND POWER QFN

The emergence of thinner form factor requirement, the QFN package has primarily become a popular choice because of its size and electrical performance. However, there is a draw back in wire bonding process using QFN lead frames. The polyimide tape adhered underneath the QFN lead fingers introduce a certain level of difficulty in stitch bonding.

SPT’s specially pipelined designed heater block provides maximum vacuum suction while accommodating a larger QFN panel per index- in order to achieve a stable support during stitch bond formation with minimal bouncing effect.

HB SOLUTION FOR COPPER WIRE BONDING

SPT provides innovative solution for copper wire bonding using heater block design with multi-holes and window clamp- arranged in such a way providing optimum supply of nitrogen forming gas to prevent package oxidation.
### WINDOW CLAMPS & HEATER BLOCKS

<table>
<thead>
<tr>
<th>Shinkawa Bonder</th>
<th>KNS Bonder</th>
<th>Esec Bonder</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Shinkawa Bonder Image" /></td>
<td><img src="image2" alt="KNS Bonder Image" /></td>
<td><img src="image3" alt="Esec Bonder Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASM Bonder</th>
<th>Shinkawa SDW 35 Bonder</th>
<th>Kaju Bonder</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="ASM Bonder Image" /></td>
<td><img src="image5" alt="Shinkawa SDW 35 Bonder Image" /></td>
<td><img src="image6" alt="Kaju Bonder Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OE 360 Bonder Finger Clamp</th>
<th>OE 360 Bonder Anvil Block</th>
<th>OE7200 Bonder Finger</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7" alt="OE 360 Bonder Finger Clamp Image" /></td>
<td><img src="image8" alt="OE 360 Bonder Anvil Block Image" /></td>
<td><img src="image9" alt="OE7200 Bonder Finger Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Canon / NEC Die Bonder</th>
<th>ASM 896 Die Bonder</th>
<th>ASM 8930 Die Bonder</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image10" alt="Canon / NEC Die Bonder Image" /></td>
<td><img src="image11" alt="ASM 896 Die Bonder Image" /></td>
<td><img src="image12" alt="ASM 8930 Die Bonder Image" /></td>
</tr>
</tbody>
</table>

### How To Order

HBXX - User Code - Bonder Model - Package Type (Batch Number)

- **HBXX**: Part Type + Bonding Window Quantity
- **HB**: order both clamp and heater block
- **HBC**: order clamp only
- **HBH**: order heater block only

Example: HB4X - Semicon - ASM 339 - QFP208L (A123)
CAPILLARY WIRE BONDING TOOLS REQUIREMENT CHECKLIST

SPT Roth Ltd
(Switzerland)
E-mail: info@sprotth.com
Fax: ++ 41 32 387 80 88

Small Precision Tools Inc
(California, USA)
E-mail: info@sptica.com
Fax: +1 707 778 2271

SPT Asia Pte Ltd
(Singapore)
E-mail: info@sptasia.com
Fax: 65 6250 2725

Small Precision Tools
(Phil) Corp
(Philippines)
E-mail: info@sptphil.com
Fax: 632 521-5780

Small Precision Tools
Co Ltd
(China)
E-mail: info@sptchina.com
Fax: 86 510 8516 5233

SPT Japan Co. Ltd
(Japan)
E-mail: info@sptjapan.com
Fax: +81 45 470 6755

Customer: ____________________________  Date: __/__/____
Department: __________________________ Contact No: ________  Extn: ________
Company: ____________________________  Order taken by: __________________________

Application: __________________________
Lead Count: __________________________

Wire Diameter: _______________________
Bonder / Model: _______________________

Bond Pad Size: ________________________
Pad Pitch: ____________________________
Loop Height (target): _________________
Mashed Ball Diameter: ________________
Bond Pad Metallization: ________________

Distance between Pad to Lead: ______________
Lead Width: ___________________________
Lead Pitch: ____________________________
Lead Metallization: ______________________

Bonding Temperature: ___________________
Ultrasonic Bonding Frequency: __________

Present Capillary Part Number(s): ______________
________________________________________
________________________________________

Wire Bonding Top 3 Defects: _______________
________________________________________
________________________________________

Any Other Wire Bonding problems? ______________
________________________________________
________________________________________

Recommended SPT Capillary Part No: ______________
________________________________________
________________________________________
EFO WAND REQUIREMENT CHECKLIST

Customer: ____________________________ Date: ___ / ___ / ___

Department: __________________________ Contact No: __________ Extn: ___

Company: ____________________________ Order taken by: __________________

Application: __________________________

Bonder / Model: _______________________

Wire Type / Diameter: __________________

Any Specific problems:
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

Recommended SPT EFO Wand Part No: ________________________________

SPT Roth Ltd
(Switzerland)
E-mail: info@sptroth.com
Fax: ++ 41 32 387 80 88

Small Precision Tools Inc
(California, USA)
E-mail: info@sptica.com
Fax: 1 707 778 2271

SPT Asia Pte Ltd
(Singapore)
E-mail: info@sptasia.com
Fax: 65 6250 2725

Small Precision Tools
(Phil) Corp
(Philippines)
E-mail: info@sptphil.com
Fax: 632 531-5790

Small Precision Tools
Co Ltd
(China)
E-mail: info@sptchina.com
Fax: 86 510 8516 5233

SPT Japan Co. Ltd
(Japan)
E-mail: info@sptjapan.com
Fax: +81 45 470 6755

SPT Roth Ltd
(Switzerland)
E-mail: info@sptroth.com
Fax: ++ 41 32 387 80 88

Small Precision Tools Inc
(California, USA)
E-mail: info@sptica.com
Fax: 1 707 778 2271

SPT Asia Pte Ltd
(Singapore)
E-mail: info@sptasia.com
Fax: 65 6250 2725

Small Precision Tools
(Phil) Corp
(Philippines)
E-mail: info@sptphil.com
Fax: 632 531-5790

SPT Asia Pte Ltd
(Singapore)
E-mail: info@sptasia.com
Fax: 65 6250 2725

Small Precision Tools
Co Ltd
(China)
E-mail: info@sptchina.com
Fax: 86 510 8516 5233

SPT Japan Co. Ltd
(Japan)
E-mail: info@sptjapan.com
Fax: +81 45 470 6755
HEATER BLOCK REQUIREMENT CHECKLIST

Customer : ___________________________ Date : __/__/____
Department : ________________________ Contact No : ______ Extn : _____
Company : ___________________________ Order taken by : ______________

Package Type : 

- QFP
- BGA
- TSOP
- SOIC
- DIP
- QFN

- Others (Please specify)  
  Please provide bonding diagram

Bonder / Model : ______________________
L/F detailed drawing (Auto CAD appreciated) _______________________
Window Quantity : ____________________

Part Type Ordered : 

- HB : order both clamp and heater block
- HBC : order clamp only
- HBH : order heater block only

Special Request : ______________________

Any Specific Problems? : ______________________

_____________________________________

_____________________________________

_____________________________________

Recommended SPT HB Part No. & Drawing No. : ______________________

______________________________
SPT Roth Ltd
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Tel: ++ 41 32 387 80 80
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