Manual Ball Bonder Short Course

Ball Bond Technology
Wire Bonder Short Course

Wire: 0.0003" to 0.003" dia.
Al or Au
Substrate: 300°C
Needle: 150°C
Gas: N₂

Tungsten carbide heated wedge
Heated substrate
Al Bonding pad
Capillary wire feed
INTEGRATED CIRCUIT

Wire Bonding c1957
Transducer Assembly with Capillary and Heater Coil for Thermocompression Ball Bonding
Simple Circuits may use Thermocompression Bonding
Transducer Assembly
With capillary for Thermosonic or Ultrasonic Ball Bonding
Ball Bond (1st Bond) Formation Thermosonic
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Ball Bond (1st Bond) Formation

Ultrasonic
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The 9 Stages

of a

Complete Bonding Cycle
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Stage 1
Free Air Ball Formation (clamps closed)

Stage 2
Free Air Ball is gripped in the capillary chamfer (clamps open)

Stage 3
1st Bond Formation
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Stage 5

Capillary Rises to loop height position
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Stage 6
Loop Formation

Stage 7
Second Bond Formation
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Stage 8-1
Creation of Tail Length (Tail Pole)

Stage 8-2
Disconnection of the Tail (Tail Break)

Stage 9
Formation of a New FAB
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Manual Machine Operation

Operator maintains precise control of a Manual Machine
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Typical Wire Bond Diagram
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A Step in Loop Formation during Ball Bonding
Tail bond Area is very small
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Typical Capillary Tip Dimensions
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Capillary Dimensions

Capillary Detailed Dimensions

Capillary Parameters:
- FA - Face Angle
- OR - Outer Radius
- H - Hole Diameter
- CD - Chamfer Diameter
- T - Tip Diameter
- ICA - Inner Chamfer Angle
- OD - Outer Diameter
- CA - Cone Angle
- L - Length
- BTNK H - Bottleneck Height
- BTNK A - Bottleneck Angle
Close Center Bonds
Manual Ball Bonder Short Course

Capillary Dimensions

* (180:1)

Capillary Parameters:
- FA - Face Angle
- OR - Outer Radius
- H - Hole Diameter
- CD - Chamfer Diameter
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- BTNK A - Bottleneck Angle

Capillary Detailed Dimensions
Examples of Bonded Balls

A bond formed by $90^\circ$ chamfer

A bond formed by $120^\circ$ chamfer
### K&S Capillary Design Recommendations

<table>
<thead>
<tr>
<th>Wire Diameter (mil)</th>
<th>Recommended Hole (mil)</th>
<th>Minimum Hole (mil)</th>
</tr>
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<tbody>
<tr>
<td>2.00</td>
<td>3.00</td>
<td>2.40</td>
</tr>
<tr>
<td>1.50</td>
<td>2.20</td>
<td>1.80</td>
</tr>
<tr>
<td>1.30</td>
<td>1.80</td>
<td>1.50</td>
</tr>
<tr>
<td>1.20</td>
<td>1.70</td>
<td>1.40</td>
</tr>
<tr>
<td>1.10</td>
<td>1.60</td>
<td>1.30</td>
</tr>
<tr>
<td>1.00</td>
<td>1.50</td>
<td>1.20</td>
</tr>
<tr>
<td>0.90</td>
<td>1.20</td>
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<tr>
<td>0.80</td>
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<td>0.95</td>
</tr>
<tr>
<td>0.70</td>
<td>0.90</td>
<td>0.85</td>
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</tbody>
</table>

**Capillary Hole Size vs. Wire Diameter**
Manual Ball Bonder Short Course

Looping

Contact with Hole
Corner of Hole and IC
Corner of IC and Tip Face

Engineering Considerations
Capillary Hole Size is Critical

Contact with Hole
Corner of Hole and IC
Corner of IC and Tip Face
Capillary Dimensions

Capillary Detailed Dimensions
The Capillary controls 2nd Bond Shape and Strength
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Capillary makes 2nd Bond and Tail Bond Simultaneously
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Capillary Effective Face Cross Section

4 vs. 7 mil tip 8 vs. 15 degree face angle

Yoolbum 8/01
Typical Gold Grain - Cross Section of Wire
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Tail for Ball Formation

Tail must be available for Ball Formation
"Free Air"
Ball Formation

Note: Clamps are Closed
Transducer Assembly with Capillary
A Thermosonic 1st Ball Bond Formation
Motorized Indexer on Manual Wire Bonding Machine