FINE PITCH CAPILLARY BASIC DESIGN DIMENSIONS

Fine pitch capillaries have two basic sets of industry standard dimensional characteristics: large geometry and small geometry. Large geometry dimensions generally refer to the shank, back hole, and cone. Small geometry dimensions refer to the tip and angle bottleneck details.

As with standard capillaries, fine pitch capillaries share the basic common dimensions such as shank diameter and overall tool length. The major dimensional differences exist at the tip details of the tool and in the specialized "angle bottleneck" construction. Wider cone angles, such as 50°, and more narrow cone angles, 20°, are often preferred over the standard 30° cone angle for ultrasonic tuning and package clearance reasons.

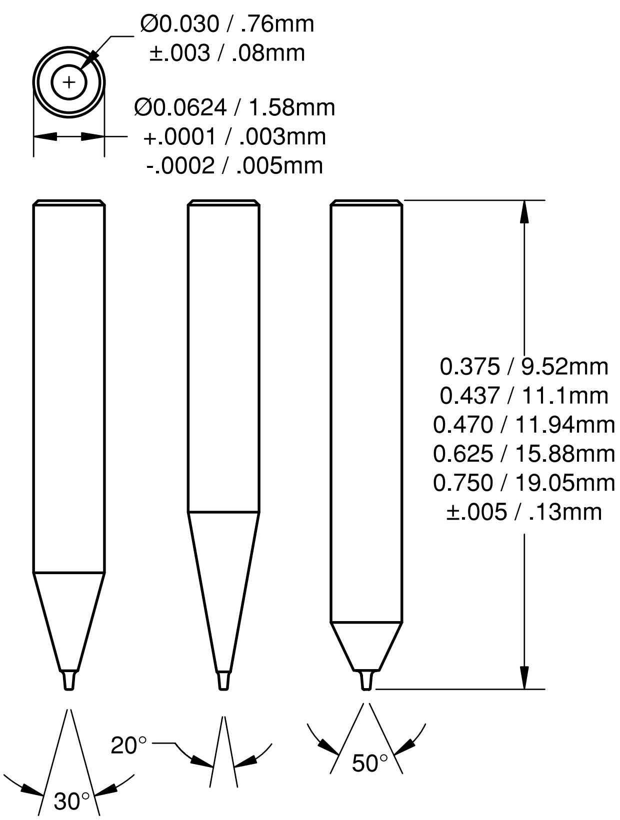

Figure 44. Large geometry dimensions

Industry standard large geometry dimensions:

1. Shank Diameter (SD)
2. Tool Length (L)
3. Cone Angle or Main Taper Angle
4. Back Hole

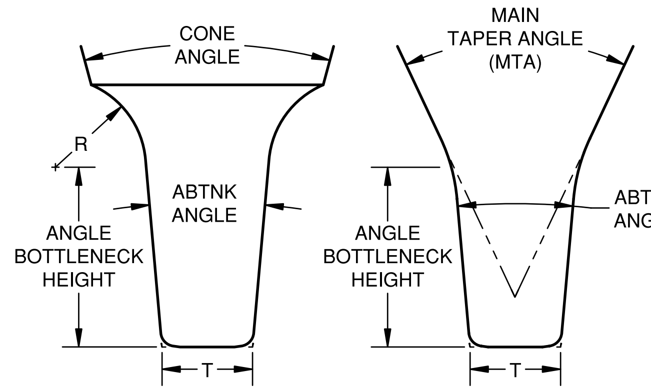

Figure 45. Angle bottleneck (ABTNK or AB) geometry dimensions

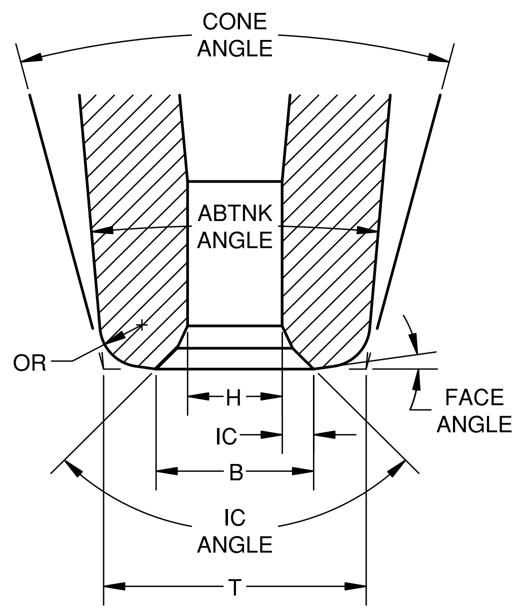

Figure 46. Small (tip) geometry dimensions

Industry standard fine pitch small geometry dimensions:

1. Tip Diameter (T)
2. Hole Diameter or Size (H)
3. Chamfer Diameter (CD or B)
4. Inside Chamfer (IC)
5. Inside Chamfer Angle (IC Angle)
6. Face Angle (Note: may be flat, 0°)
7. Outside Radius (OR)
8. Angle Bottleneck Angle (AB or ABTNK Angle)
9. Angle Bottleneck Angle (AB or ABTNK Height)

FINE PITCH PROCESS REQUIREMENTS

Below are some basic requirements for fine pitch bonding processes:

1. Consistent wire diameter
2. State-of-the-art wire bonder
3. Substrate material and design for fine pitch process
4. Capillary bottleneck designs and materials
5. Molding and mold compound suitability

PROCESS OPTIMIZATION

The following are some general quality guidelines and requirements for optimization in a typical fine pitch bonding application:

1. Ball shear ratio ≥ ~ 6 gm/mil^2
2. Pull strength ≥ ~ 6 gm
3. Bonded ball size for fine pitch = 1.8 to 2.2 times the wire diameter
4. Bonded ball size for ultra fine pitch = 1.5 to 1.8 times the wire diameter
5. Capillary tip diameter = 1.28 times the pad pitch

CAPILLARY DESIGN CONSIDERATIONS

The bond pad opening (BPO) restricts the size of the bonded ball and the bond pad pitch (BPP) controls the optimum size of the capillary tip diameter that can be used. It is essential that the bonded ball be placed completely within the BPO. The capillary tip diameter must be large enough to provide a strong second bond but also clear any adjacent wires during the bonding process.

1. Hole Diameter (H): For fine pitch applications, a hole to wire clearance can be 0.0003 in./7.6µm for 70µm-90µm pitch, 0.0002 in./5µm for 60µm pitch, and 0.00015 in./3.5µm for 50µm pitch bonding. This is critical to insure good wire movement with the hole during looping without causing wire drag resulting in sagging, wavy, or tight loops.

2. Chamfer Diameter (CD or B): The contribution of the CD is to control the bonded ball size. With the bond pad opening (BPO) as a limiting factor, the selection of the proper CD is very important. Typically, the IC size for 0.0009 in./23µm to 0.0010 in./25µm wire is 0.0002 in./5µm to 0.00025 in./6µm. When using 0.0012 in./30µm wire, the typical IC size can range from 0.00025 in./6µm to 0.0003 in./8µm.

3. Inside Chamfer Angle (IC Angle): The most common angle for fine pitch bonding is 90°. For some ultra fine pitch applications, an angle of 40° to 70° is selected to reduce the bonded ball size. Poor ball shear results may stem from these steeper angles.

4. Angle Bottleneck Angle: This angle is critical for the capillary to avoid contact with adjoining loops during wire bonding. Generally, 10° is recommended but 5° may be required for some ultra fine pitch applications.

5. Angle Bottleneck Height: The height required depends on the critical loop heights immediately adjacent to the capillary or those wires which the capillary must pass between when bonding to staggered bond pads. A standard height is 0.010 in./254µm.

6. Tip Diameter (T): Optimal tip diameter selection is determined by the BPP and the desired loop height to be cleared. Loop configuration must also be considered when bonding in the corners of some devices.

Pitch *µm*	T Size in./*µm*	Ball Size in./*µm*
100	.0050/*127* to .0052/*132*	.00295/*75* to .00335/*85*
90	.0043/*109* to .0047/*119*	.0028/*70* to .00295/*75*
80	.0040/*102*	.0026/*65* to .0028/*70*
70	.0035/*89* to .0038/*97*	.0020/*52* to .0023/*58*
65	.0032/*81* to .0035/*89*	.0018/*45* to .0019/*49*
60	.0030/*76* to .0032/*81*	.0018/*45* to .00185/*47*
50	.0025/*64*	.0014/*36* to .0016/*40*

Pitch *µm*	Ball Shear	Pull Strength
100	47 gm	>9 gm
90	38.5 gm	>8 gm
80	34.3 gm	>7.5 gm
70	22.7 gm	>5 gm
65	18.1 gm	>4 gm
60	16.3 gm	>3.8 gm

FINE PITCH WIRE BONDING

The miniaturization and shrinkage of silicon chips has lead to considerable wafer cost savings. However, it requires much closer wire to wire spacing, smaller deformed ball bonds, and complex looping to prevent looping problems. In order to support and challenge the ultra fine pitch technology roadmap, Gaiser Tool Company utilizes state-of-the-art enabling technologies to gain competitive advantages.

PROCESS 1800

As the semiconductor industry moved to finer and finer pitches, the demand for smaller angle bottleneck tip diameters and tighter dimensional tolerances grew. Gaiser Tool Company recognized this need and developed the Process 1800 manufacturing process.

Process 1800 eliminated the previously standard grinding operation now leaving the angle bottleneck portion with a high-tension, mirror smooth, secondary alumina skin.

- The newest bottleneck manufacturing technology providing superior bottleneck strength
- Increased shear strength and rigidity
- Superior ultrasonic energy transmission and a wider tuning window
- Substantially tighter dimensional tolerances
- Reduced standard deviations
- Sub-micron average grain size, near-zero porosity of the ceramic and zirconia toughened ceramic materials
- Ideal for high-frequency transducers

Figure 47. Process 1800 style angle bottleneck

Capillary Tolerances		
Dimension	**Standard Tools T≥.0050/*127* in./µm**	**Process 1800 T<.0050/*127* in./µm**
T	±.0003/*8*	±.00015/*3.8*
H	±.0001/*2.5*	±.00005/*1.3*
B (CD)	±.0002/*5*	±.0001/*2.5*
OR	±.0003/*8*	±.00015/*3.8*

Fully Automatic Bonder/High Speed Bonder Fine Pitch Capillary Hole Diameter Guide	
Wire Diameter in./µm	**Hole Diameter in./µm**
.0006/*15*	.00075/*19* to .0009/*23*
.0007/*18*	.00085/*22* to .0010/*25*
.0008/*20*	.00095/*24* to .0011/*28*
.0009/*23*	.00105/*27* to .0012/*30*
.0010/*25*	.00125/*32* to .0014/*36*
.0011/*28*	.0013/*33* to .0015/*38*
.0012/*30*	.0014/*36* to .0016/*41*
.00125/*32*	.0015/38 to .0017/*43*

THE CHAMFER DIAMETER RADIUS (CDR)

The chamfer diameter radius (CDR) was developed to eliminate cut tail problems on new fine pitch devices. This design is a blending where the IC meets the face of the capillary:

- Blending of IC and tool face
- Minimizes cut tail problems
- Reduces effects of flame-off error

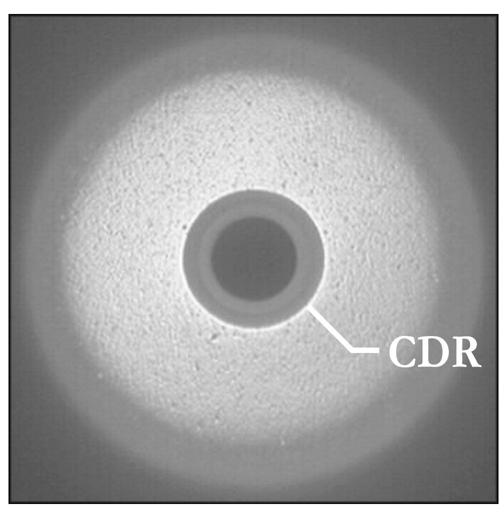

Figure 48. Example of the chamfer diameter radius (CDR)