APPLICATION NOTE

Powder Choice and Stencil Design Guidelines

Powder Choice Guidelines

Selection of the appropriate powder size for a specific solder paste application is an elemental step that will ultimately affect the printability and dispensability of the solder paste with regard to the stencil design and needle gauge. Indium Corporation manufactures low-oxide spherical powder composed of a variety of alloys that cover a broad range of melting temperatures. Powder sizes in the range of Type 1 to Type 8 are offered. Type 3, Type 4, Type 5, and Type 6 powder are standard offerings with most available alloys.

For printing applications, it is important to choose the correct powder size to prevent clogging of the smallest apertures of the stencil. For rectangular apertures, a minimum of 5 solder particles (the largest particle size of the range) should be able to fit within the width of the aperture. For square or circular apertures, a minimum of 7 solder particles should be able to fit within the width of the aperture. The largest powder type that can be consistently printed through the smallest aperture should be selected. (As the particle diameter decreases, the powder surface area increases exponentially, thereby increasing the rate of oxide formation).

The chart below illustrates powder type considerations for stencil aperture sizes. For optimal powder type selection, contact Indium Corporation's Technical Support team.

IPC Powder Type	Particle Diameter Range (µm)	Largest Particle Diameter (µm)	Minimum Rectangle Aperture Width (µm)	Minimum Square/Circle Aperture Width (µm)
3	25–45	45	225	315
4	20–38	38	190	266
5	15–25	25	125	175

When dispensing solder paste, the powder type will depend on the needle gauge. The following chart depicts powder type recommendations for a range of dispensing needles.

Dispensing													
Application		Dispensing Needle						Powder					
Pitch				Internal Diameter						Diameter Range			
Inches	Microns	Gauge	Color	Inches	Microns	# Small Spheres	# Large Spheres	Type	Mesh	Inches		Microns	
		14	olive	0.060	1,520	33.8	20.3	2	-200/+325	0.0018	0.0030	45	75
		15	amber	0.053	1,350	30.0	18.0	2	-200/+325	0.0018	0.0030	45	75
		16	gray	0.047	1,190	26.4	15.9	2	-200/+325	0.0018	0.0030	45	75
		18	green	0.033	840	18.7	11.2	2	-200/+325	0.0018	0.0030	45	75
0.050	1,270	20	pink	0.023	580	23.2	12.9	3	-325/+500	0.0010	0.0018	25	45
		21	purple	0.020	510	20.4	11.3	3	-325/+500	0.0010	0.0018	25	45
		22	blue	0.016	410	16.4	9.1	3	-325/+500	0.0010	0.0018	25	45
0.025	635	23	orange	0.013	330	13.2	7.3	3	-325/+500	0.0010	0.0018	25	45
0.020	508	25	red	0.010	250	10.0	6.6	•	-400/+500	0.0010	0.0015	25	38
0.016	406.4	25	red	0.010	250	12.5	6.6	4	-400/+635	0.0008	0.0015	20	38
0.016	406.4	27	clear	0.008	200	10.0	8.0	5	-500/+635	0.0008	0.0010	20	25
0.012	304.8	30	lavender	0.006	150	?	7.5	6	-635	fines	0.0008	fines	20

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Stencil Design Guidelines

The stencil design plays an even more crucial role in solder paste printability and should be given considerable thought with the Area Ratio as a major focus. The Area Ratio is the ratio of the area of the aperture opening to the area of the aperture walls. Industry guidelines recommend that the Area Ratio is ≥0.66. Area Ratios <0.66 will require a smaller powder particle size.

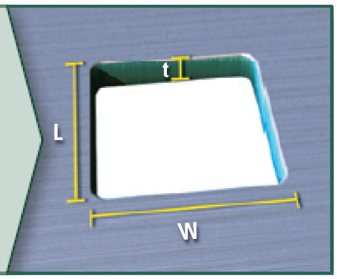
Area Ratio For Square/Rectangular Apertures

$$\text{Area Ratio} = \frac{\text{Area Opening}}{\text{Area Walls}}$$

$$\text{Area Opening} = L \times W$$

$$\text{Area Walls} = 2t(L + W)$$

$$\text{Area Ratio} = \frac{L \times W}{2t(L + W)}$$



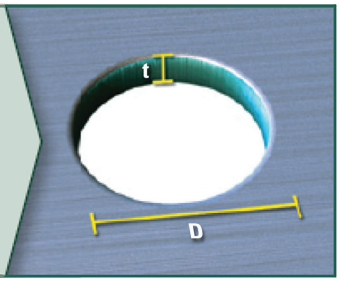
Area Ratio For Circular Apertures

$$\text{Area Ratio} = \frac{\text{Area Opening}}{\text{Area Walls}}$$

$$\text{Area Opening} = \frac{\pi D^2}{4}$$

$$\text{Area Walls} = \pi D t$$

$$\text{Area Ratio} = \frac{D}{4t}$$



The chart below depicts the Area Ratios for different combinations of aperture widths and stencil thicknesses. Any Area Ratios ≥0.66 should have adequate printing performance.

Electroformed and laser cut/electropolished stencils produce the best printing characteristics among stencil types. A nanocoated electroform stencil is preferred for its improved wear resistance and paste release. The following are a few general recommendations for aperture design:

- Discrete components—A 10–20% reduction of stencil aperture has significantly reduced or eliminated the occurrence of mid-chip solder beads. The "home plate" design is a common method for achieving this reduction.
- Fine-pitch components—A surface area reduction is recommended for apertures of 20mil pitch and finer. This reduction will help minimize solder balling and bridging that can lead to electrical shorts. The amount of reduction necessary is process-dependent (5–15% is common).
- For optimum transfer efficiency and release of the solder paste from the stencil apertures, industry standard aperture and aspect ratios should be adhered to.

Aperture Size (µm)		50	100	150	160	170	180	190	200	250	300	350	400
Aperture Size (mils)		1.97	3.94	5.91	6.30	6.69	7.09	7.48	7.87	9.84	11.81	13.78	15.75
Stencil Thickness (mils)	5	0.10	0.20	0.30	0.31	0.33	0.35	0.37	0.39	0.49	0.59	0.69	0.79
	4	0.12	0.25	0.37	0.39	0.42	0.44	0.47	0.49	0.62	0.74	0.86	0.98
	3	0.16	0.33	0.49	0.52	0.56	0.59	0.62	0.66	0.82	0.98	1.15	1.31

Not typically within process window | Attainable with newer generation products | Typically within process window

All of Indium Corporation's solder paste and preform manufacturing facilities are IATF 16949:2016 certified.
Indium Corporation is an ISO 9001:2015 registered company.

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