

# ULTRA-THIN, FINE-PITCH STEP STENCILS FOR MINIATURE COMPONENT ASSEMBLY

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## Objective:

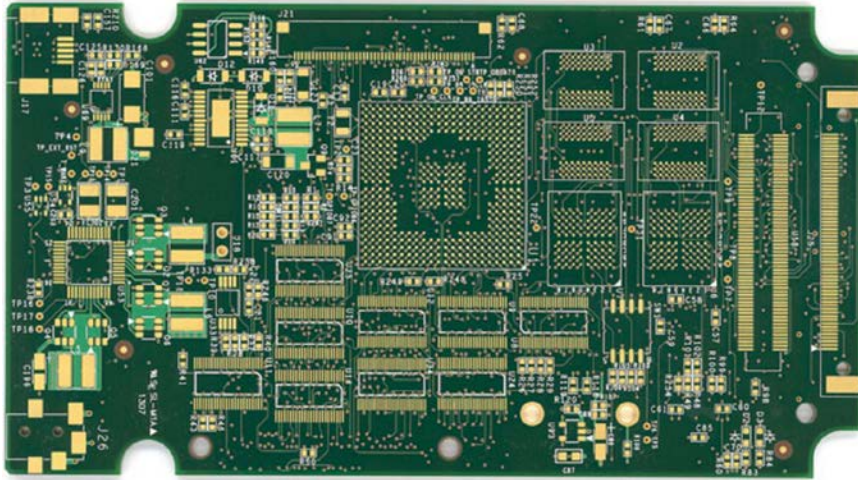
Enabling optimized solderpaste print using a single stencil to assemble miniature components such as 0.3mm pitch CSPs, 01005, 0201M, while

1. printing for large devices like RF Shields, SMT connectors, QFP's and other chip components, and/or
2. Provide relief for already printed flux on the board.  
– at the same time.

## Problem Statement:

Maintaining acceptable area ratio ( $>0.5$ ) for all pad sizes with uniform stencil thickness.

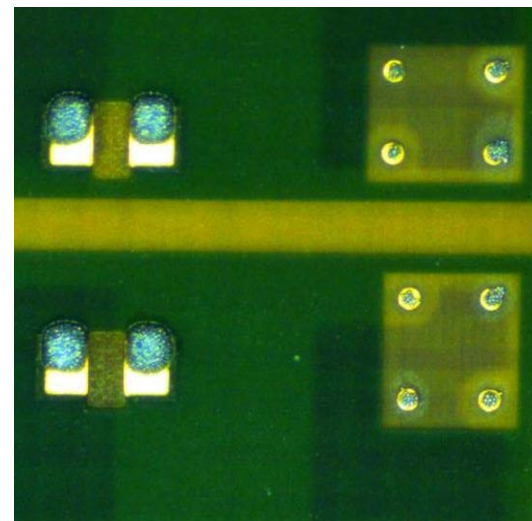
# Details



Board with Capacitors, BGA pads, QFNs, QFPs, etc.,  
=> Different pad sizes

**Print issue:** when printing SMD and NSMD pads with single thickness stencil

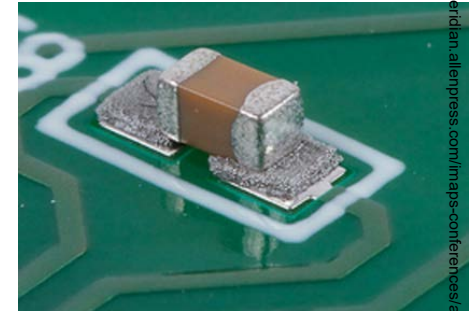
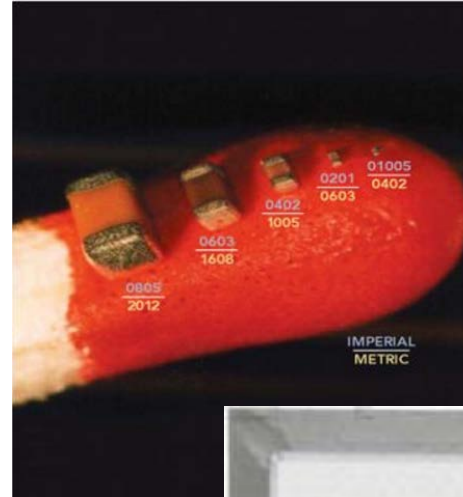
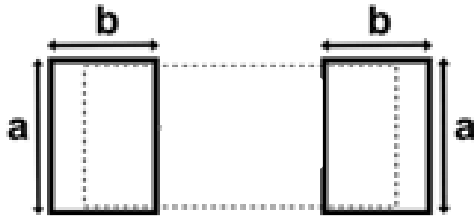
- Print offsets
- Minimal or no print on NSMD pads



# Details

Decreasing pad size of capacitor

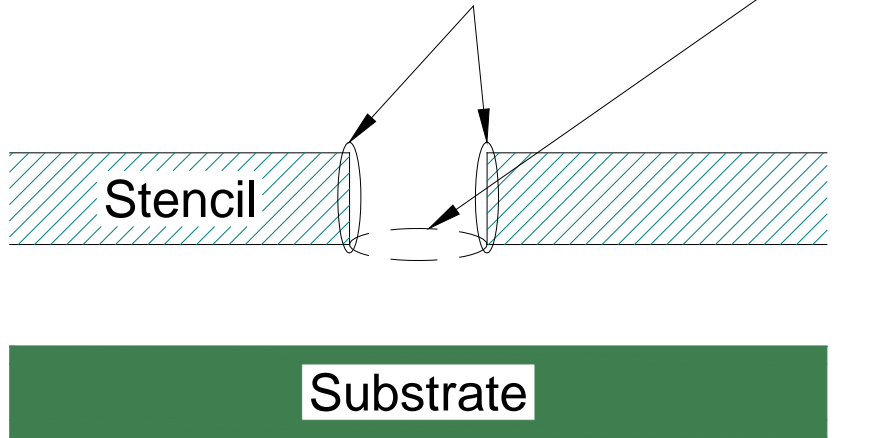
Capacitor code	Pad length (a) mm	Pad width (b) mm
0201M	100um	75um
01005	↑ Decreasing ↑	↑
0201		
0402	600um	500um



Single thickness stencil with different aperture size can lead to poor paste transfer efficiency

# What is Area Ratio (AR)

$$\text{Area Ratio} = \frac{\text{Aperture Open Area}}{\text{Wall Surface Area}}$$





For better paste transfer

## Industry Guidelines

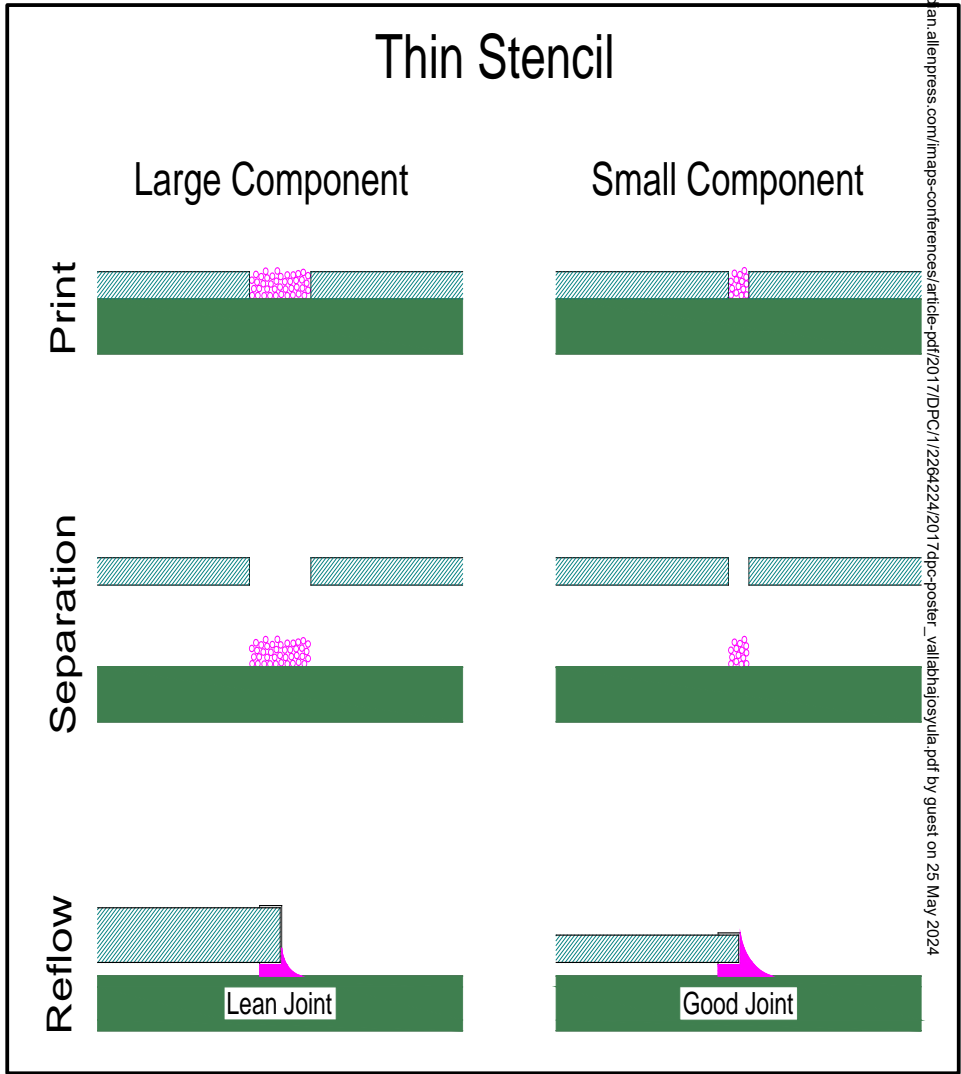
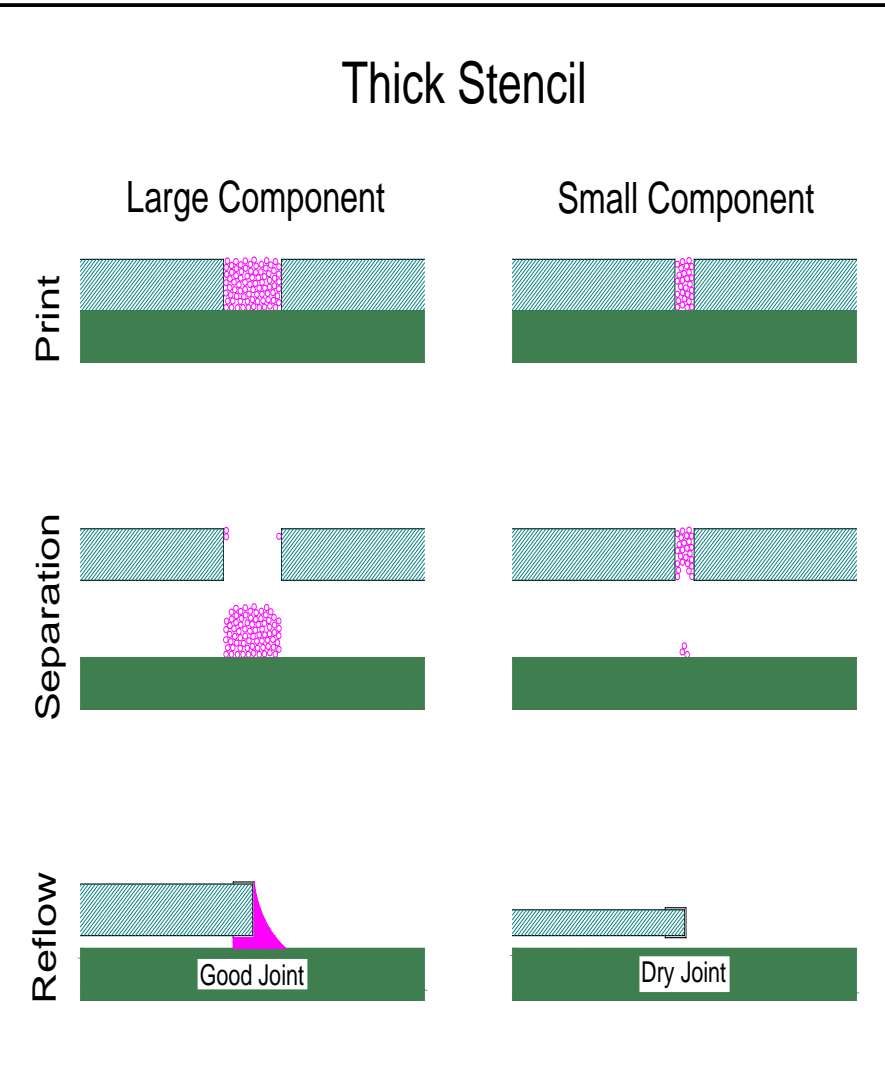
- AR > 0.66 for Laser Cut
- AR > 0.50 for Electroform

## Why is this a problem:

For best paste transfer – we need

- ❑ Thin stencil  Small devices/pads
- ❑ Thin Stencil  Large devices/pads

# Challenge of Broadband Printing large and small components on same substrate



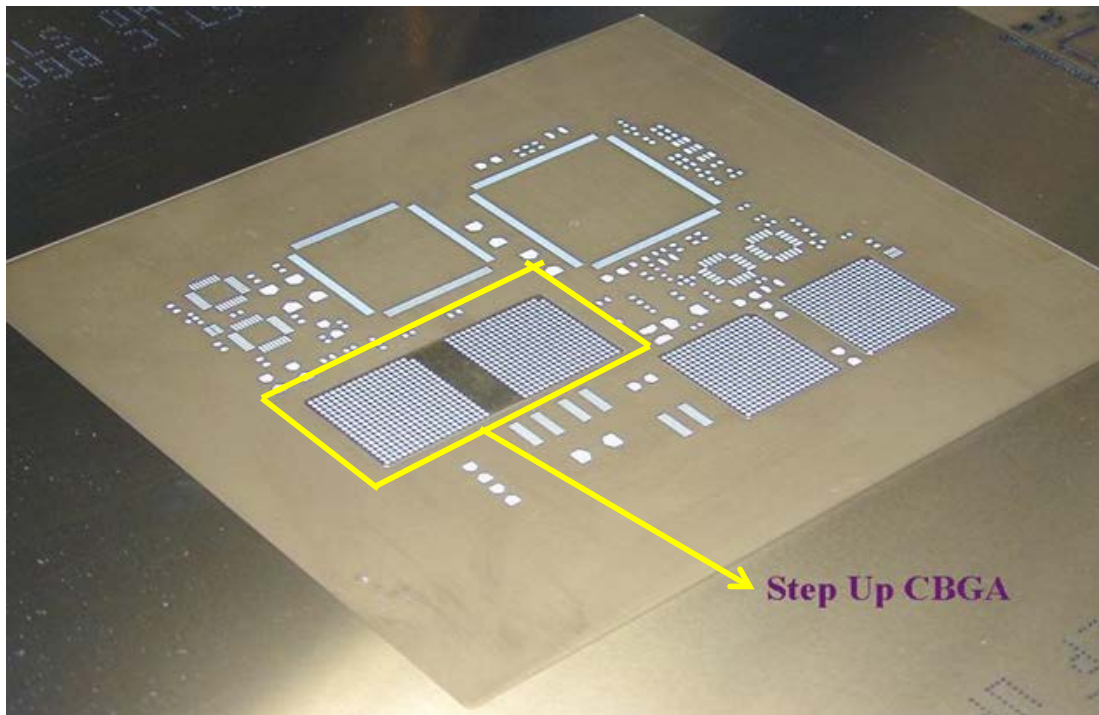
## Area Ratio Matrix

Component and typical Aperture Size ↓	Stencil Thickness →					
	2 mil 50u	2.5 mil 62u	3 mil 75u	3.5 mil 87u	4 mil 100u	5 mil 125u
<b>01005</b>						
6 mil (150u)	0.75	0.60	0.50	0.43	0.38	0.30
7 mil (175u)	0.88	0.70	0.58	0.50	0.44	0.35
<b>.3 mm CSP</b>						
6 mil (150u)	0.75	0.60	0.50	0.43	0.38	0.30
7 mil (175u)	0.88	0.70	0.58	0.50	0.44	0.35
8 mil (200u)	1.00	0.80	0.67	0.57	0.50	0.40

Green = OK    Orange = Warning    Red = Stop

## Stencil Solution: Step Stencils

1. A single stencil with varied thickness to print through
  - ✓ Thin area for small devices
  - ✓ Thick area for large devices

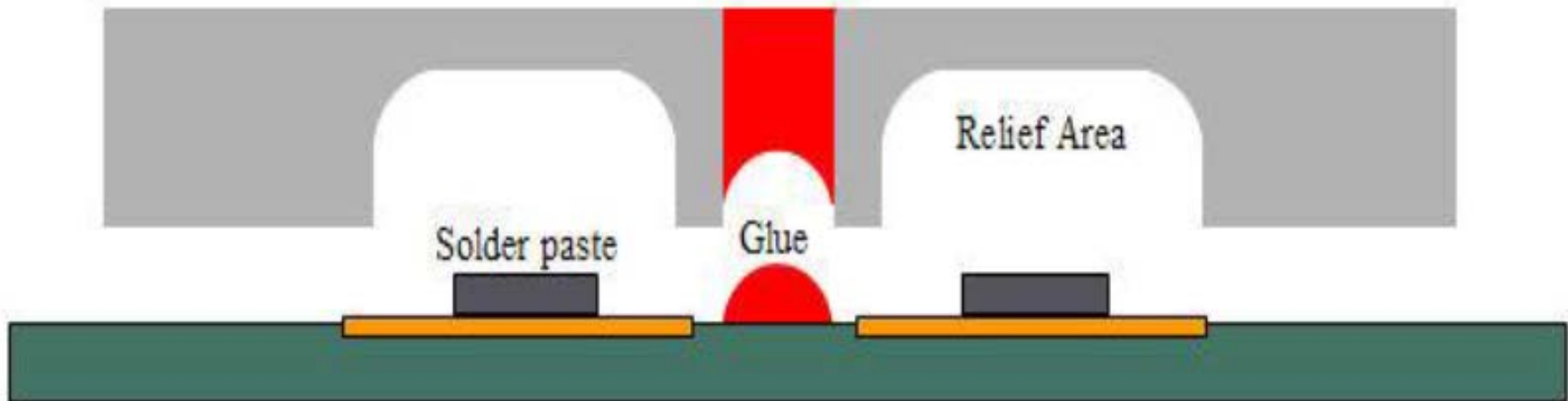




## Stencil Solution: Step Stencils

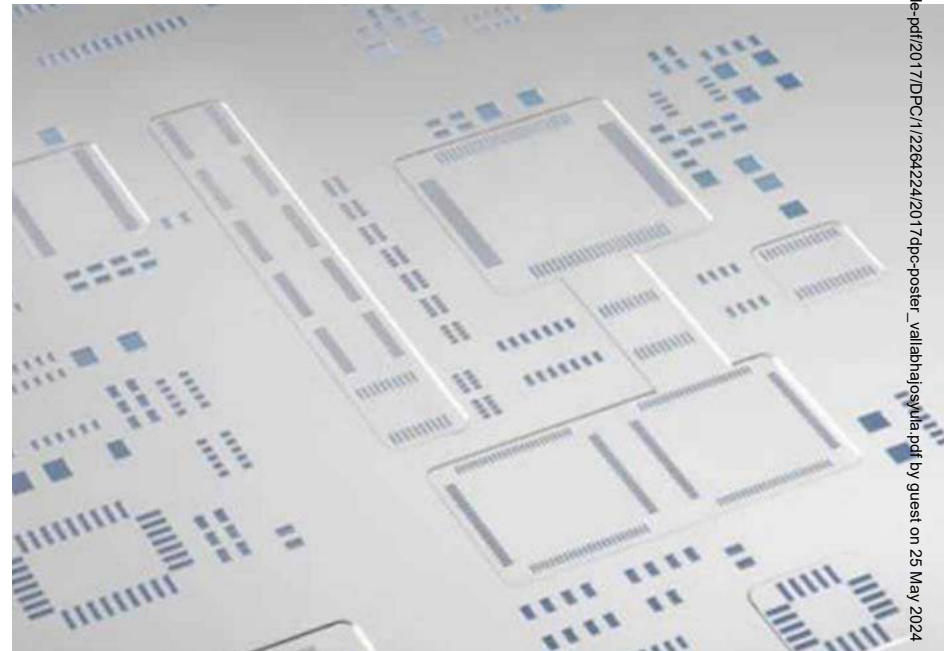
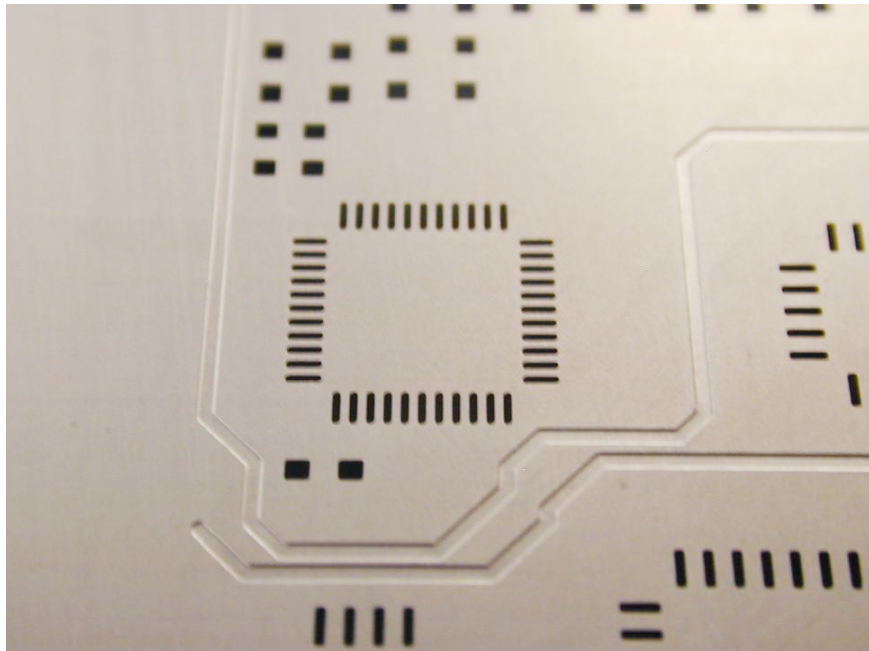
2. Two print stencil system - Second stencil of two print stencils is a **Step stencil** with relief pockets

- a. Print flux or paste with 1<sup>st</sup> stencil, followed by
- b. Print other material with 2<sup>nd</sup> stencil that has a relief pockets anywhere on areas with prior print



## Step Stencils - Manufacturing

- Steps can be etched (**Chem-etch**) or **welded (laser)** to the base foil
- Steps can also be grown using **electroform** process



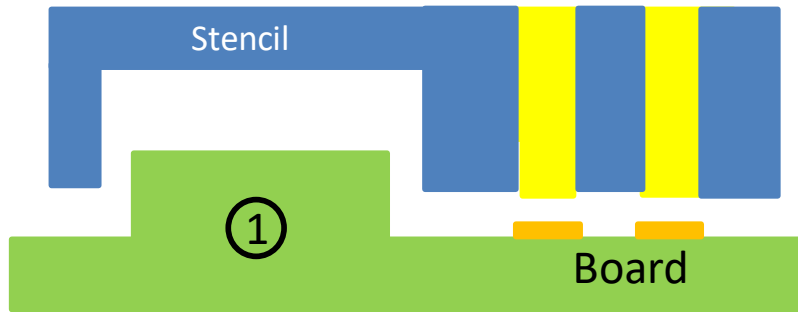
From Stencils Unlimited

Relief Etch Step Stencil for additive traces on board

# Step Stencils

Step stencils can have steps on

## 1. Board side



## 2. Squeegee side



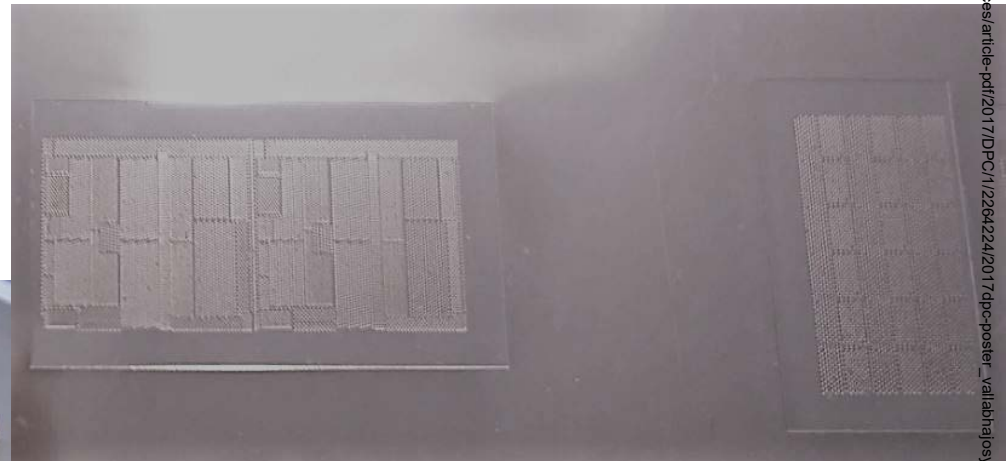
## 3. Both board and squeegee sides



## Step Stencils @ Photo Stencil

- ✓ Photo Stencil manufactures steps by Electroforming, and/or chem-etch process
- ✓ Steps as thin as 12um (0.5mils)

3-D E-FAB Squeegee side view with notched E-BLADE



E-Fab step 60um/30um, with a 70um aperture and 150um pitch

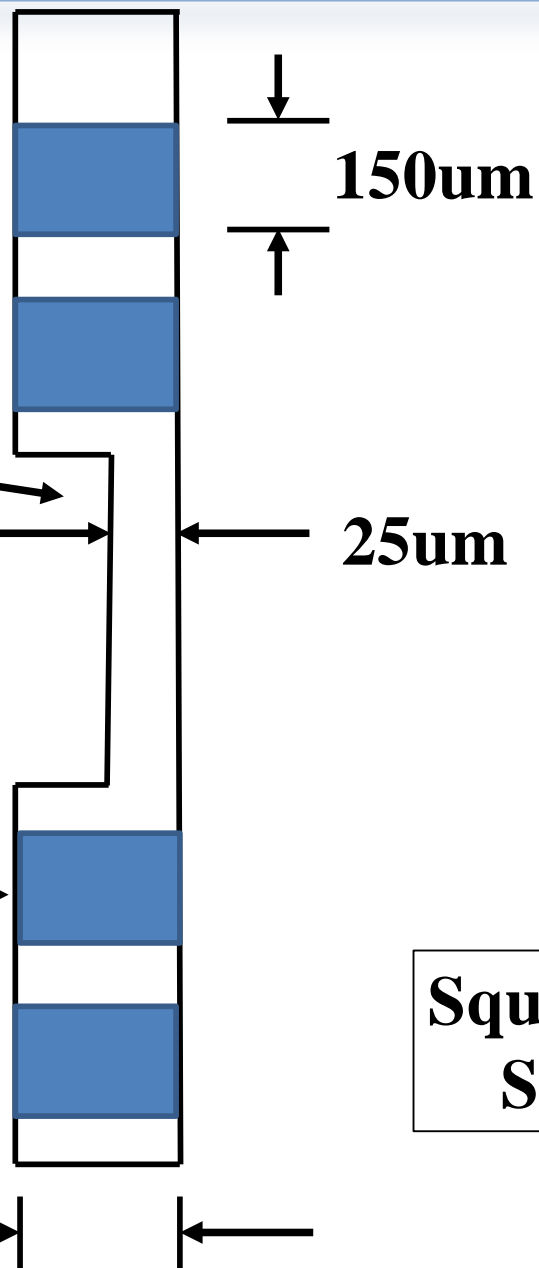
# 2<sup>nd</sup> Print Electroform Step Stencil

Flux Relief Pocket

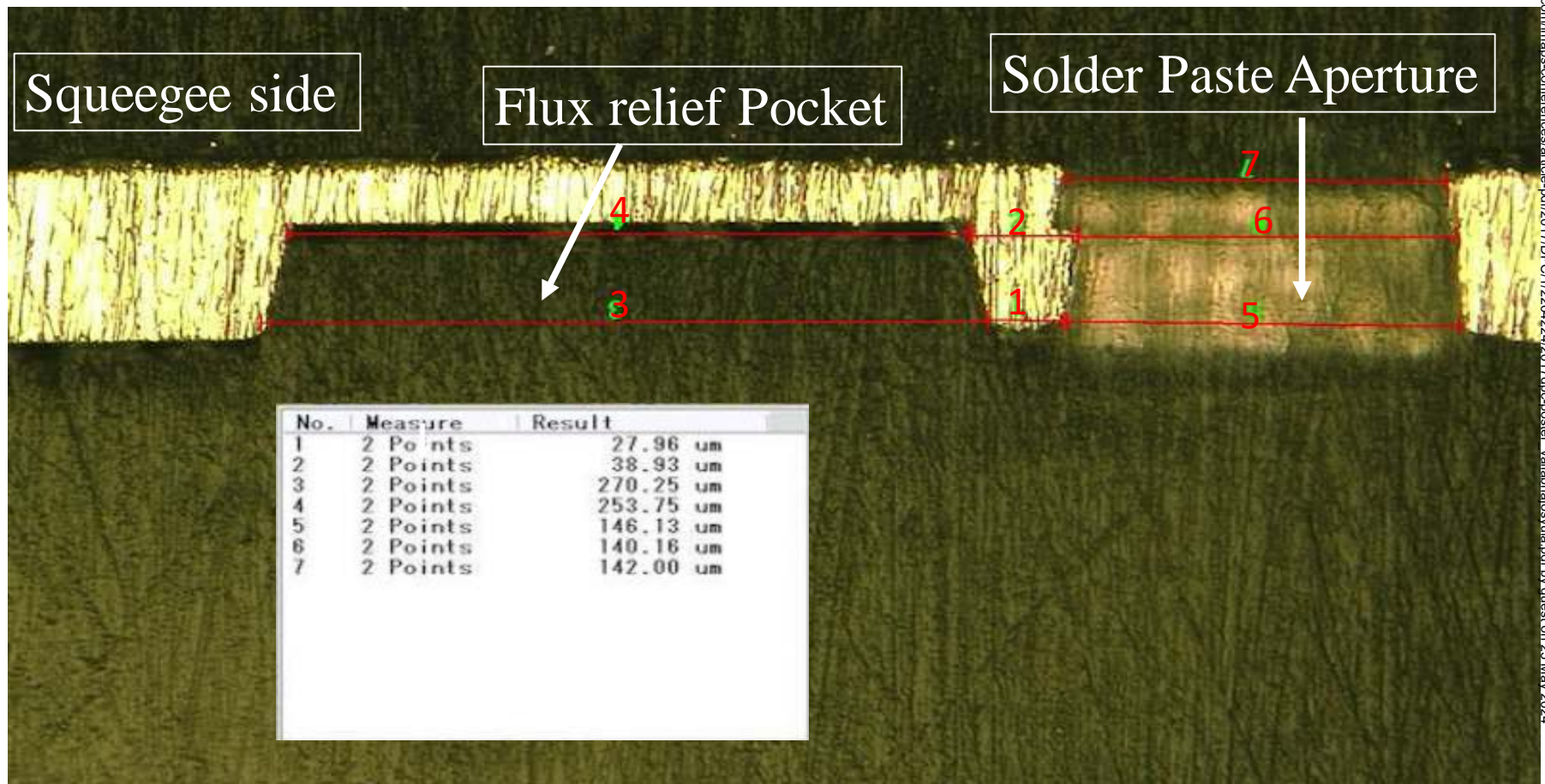
Solder Paste Aperture

Contact Side

Squeegee Side

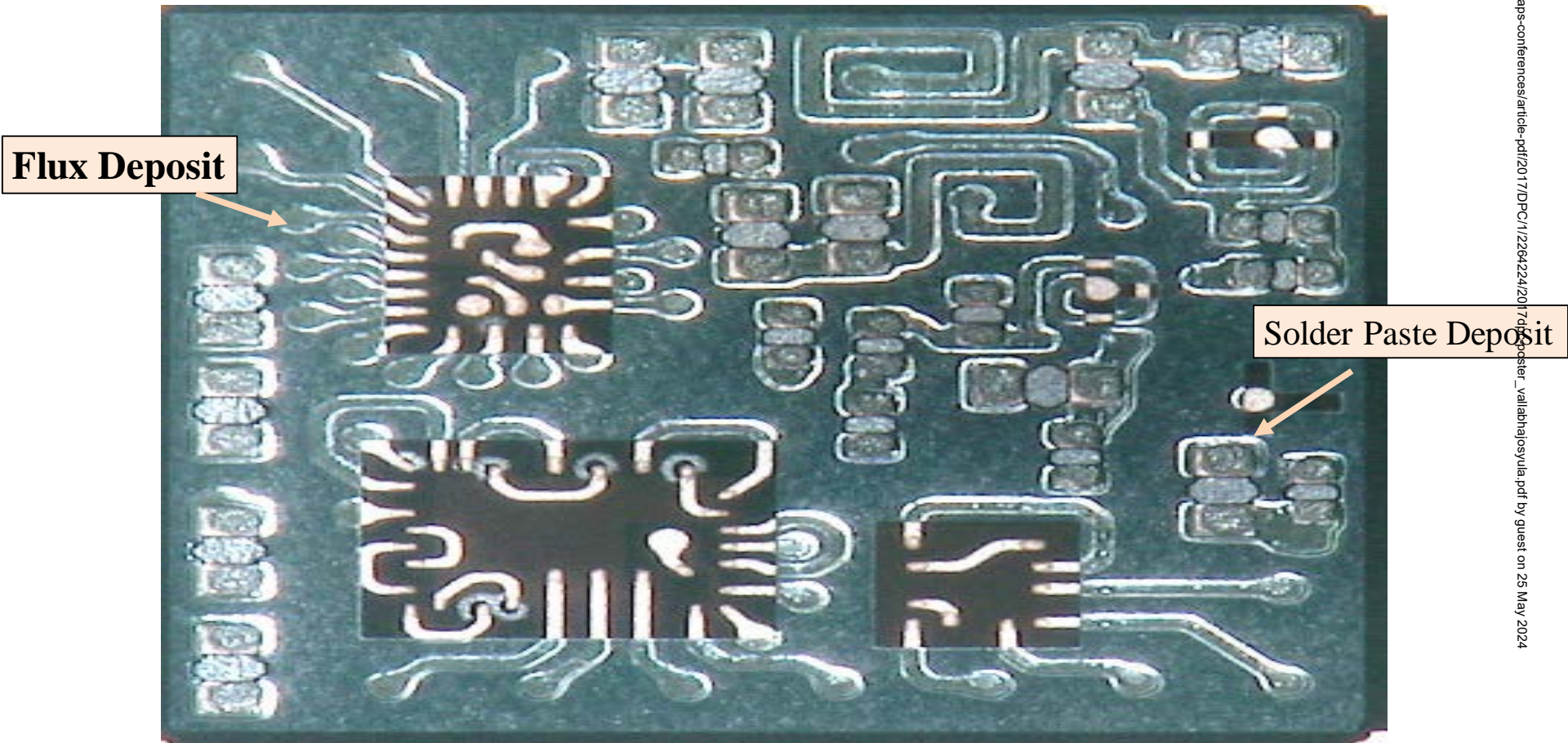


# Electroform Relief Step Stencil Cross Section 40um Space between 01005 Aperture and Relief Step Pocket.



# Example of Prints : Flux 1<sup>st</sup> Solder Paste 2<sup>nd</sup>

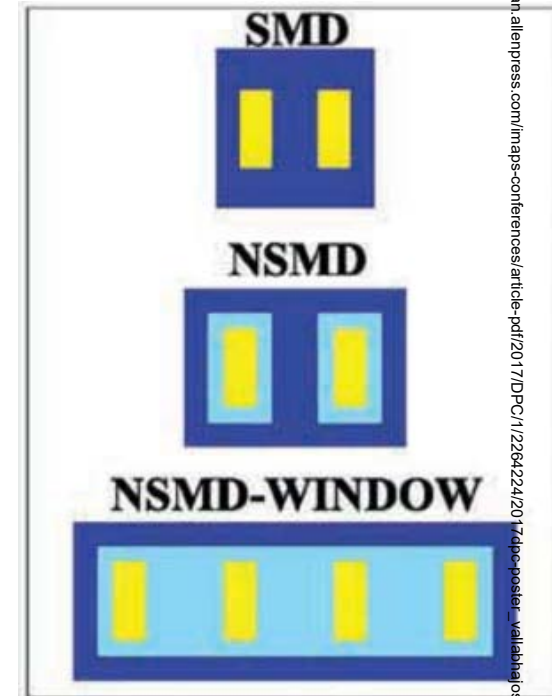
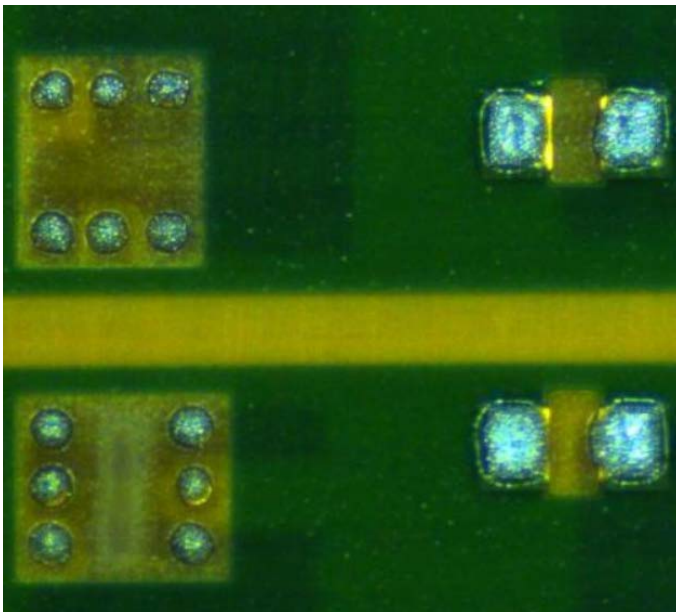
Electroform stencil 75um thick for Paste Print and 50um Deep Relief Pocket for 1<sup>st</sup> Flux Print



## Step Stencils for QFNs

- ✓ Stencil with steps to print in CSPs with SMD +NSMD pads at the same time
- ✓ Solution for printing on QFN pads with NSMD and/or NSMD window with

**Step height = Soldermask thickness**





## Step Stencil Specs @ Photo Stencil

- ✓ Min stencil thickness capability: 13um- straight
- ✓ Min half etch capability:
  - E-Fab: 12um step with +/-10% tolerance,
  - Chem etch: +/-13um increment (+/-13um tolerance)
- ✓ Thickness control for stencil fabrication technologies and etch cavity thickness control:
  - E-Fab: +/-10% of nominal thickness,
  - Chem-etch: +/- 13um

## CONCLUSION:

**Ultra thin, fine pitch Step Stencil is the solution  
for**

Enabling optimized solderpaste print using a single stencil to assemble miniature components such as 0.3mm pitch CSPs, 01005, 0201M, while

1. printing for large devices like RF Shields, SMT connectors, QFP's and other chip components, and/or
2. Provide relief for already printed flux on the board and/or
3. Print in SMD and large NSMD areas on the board  
– at the same time.