FILL THE VOID IV: ELIMINATION OF INTER-VIA VOIDING

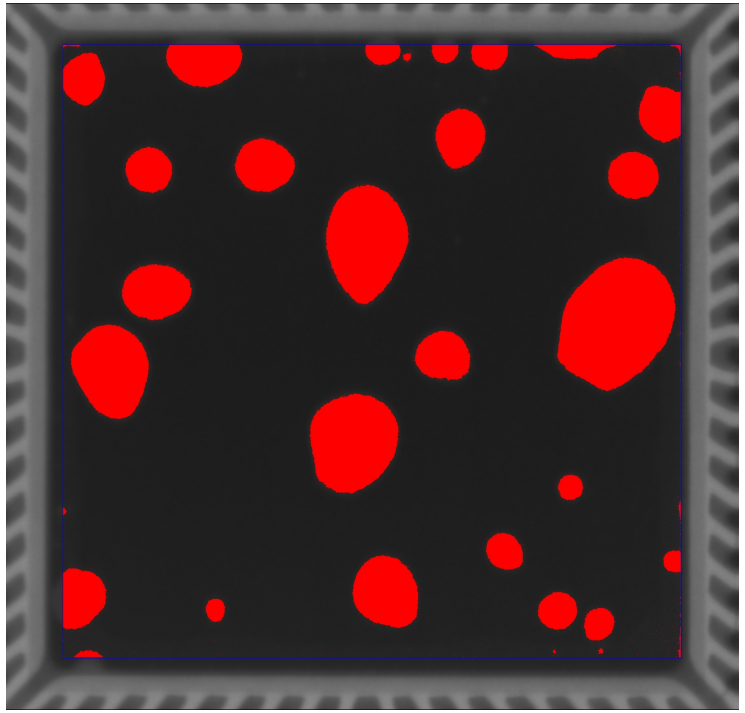
Tony Lentz

FCT Assembly

tlentz@fctassembly.com

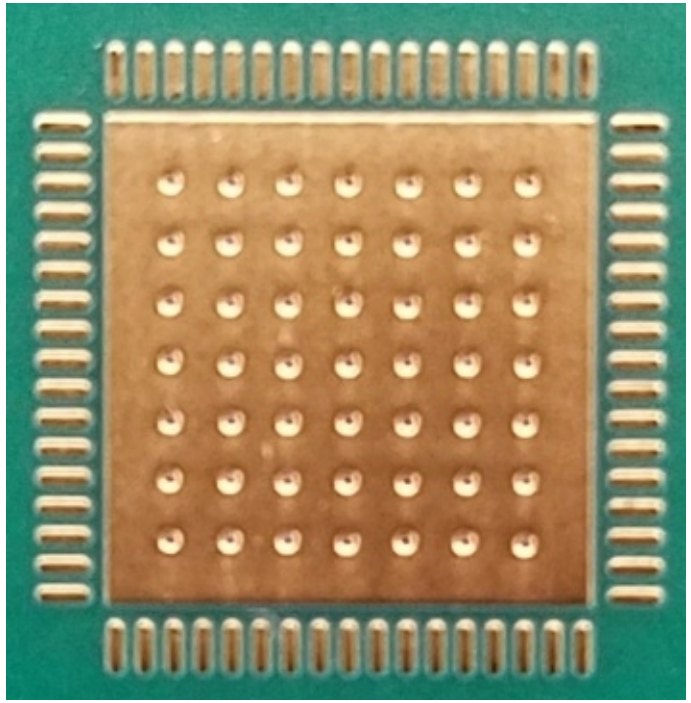
OUTLINE

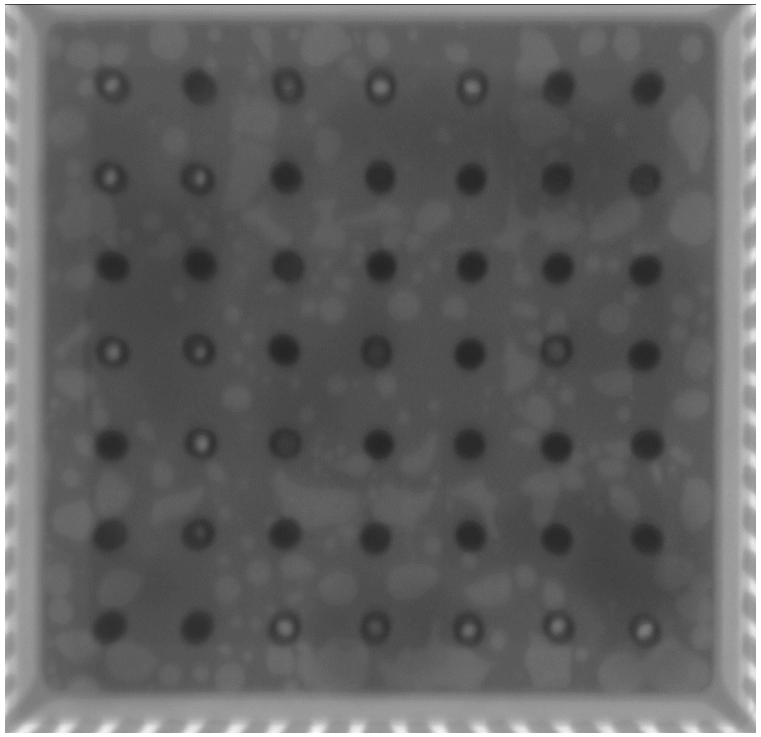
- Introduction
- Factors that Influence Voiding
- Methodology
- Voiding Results
- Recommendations to Fill the Void
- Future Work
- Acknowledgements
- Thank You & Questions

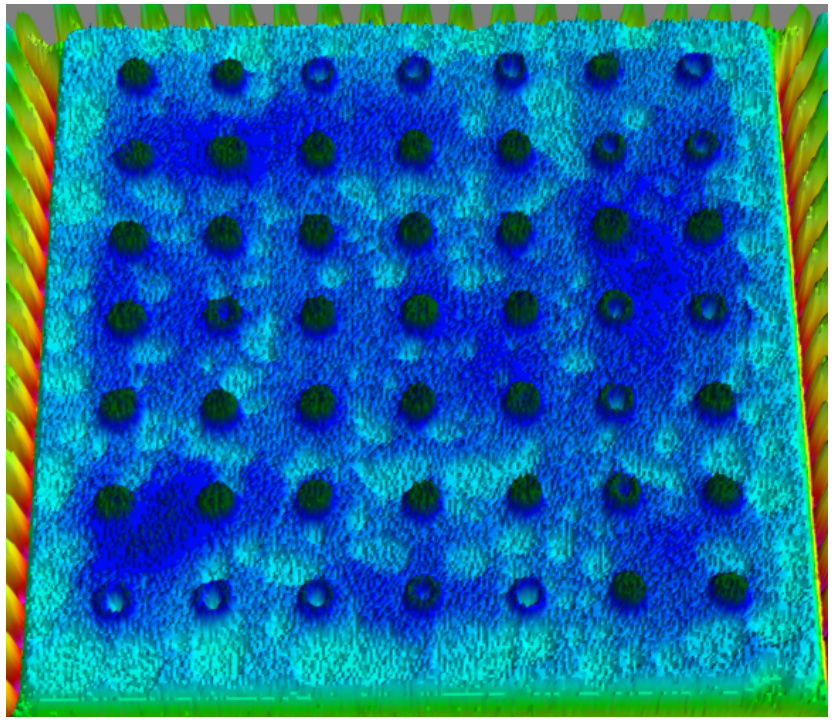


INTRODUCTION

INTRODUCTION ON VOIDING

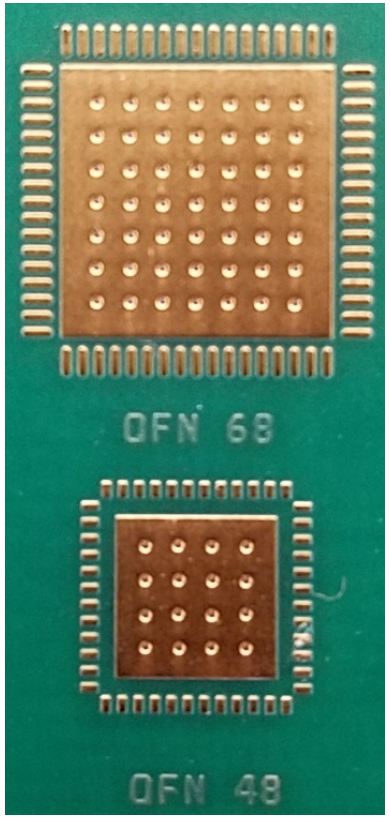


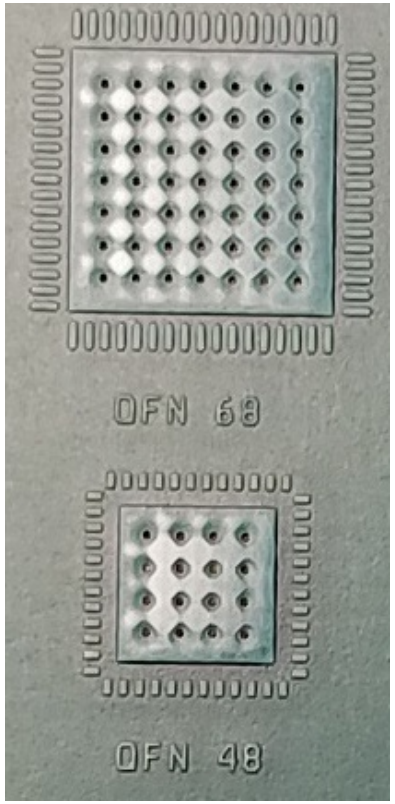


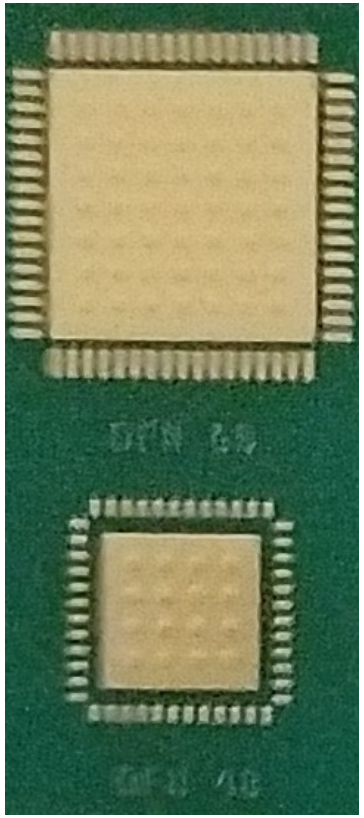


Voiding is Common for QFN Thermal Pads with Via Holes

FACTORS THAT INFLUENCE VOIDING FOR VIA-IN-PAD DESIGNS

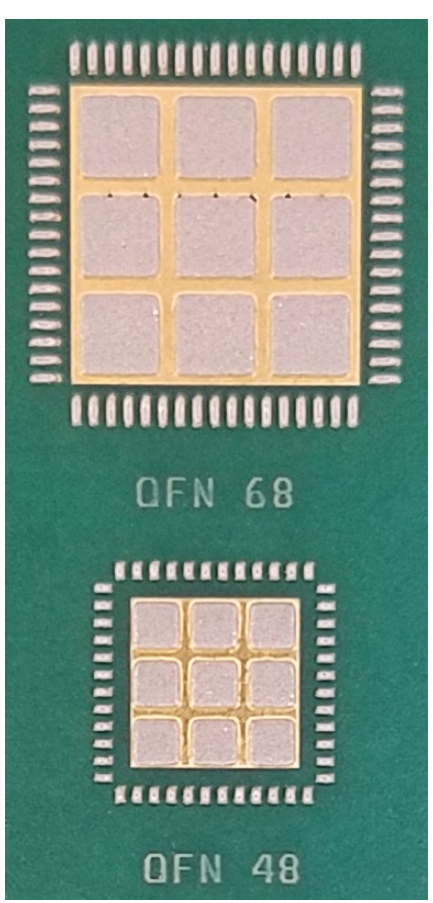


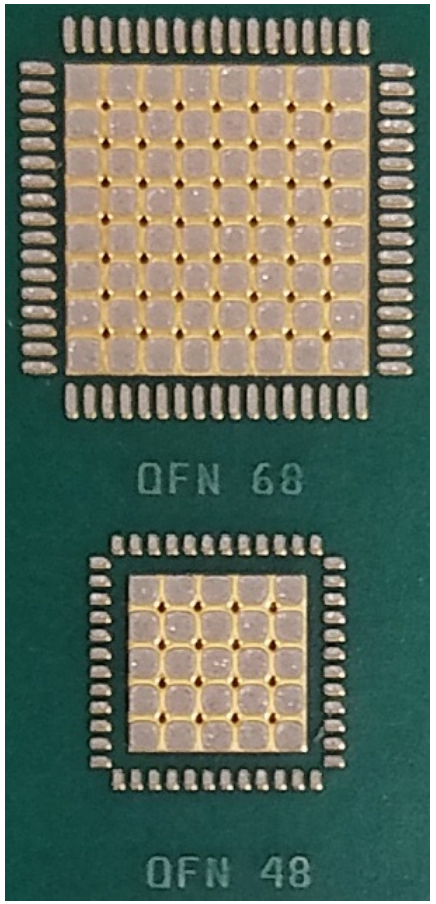




Via Hole Plugging Options: Open, S/M Tent, Plugged

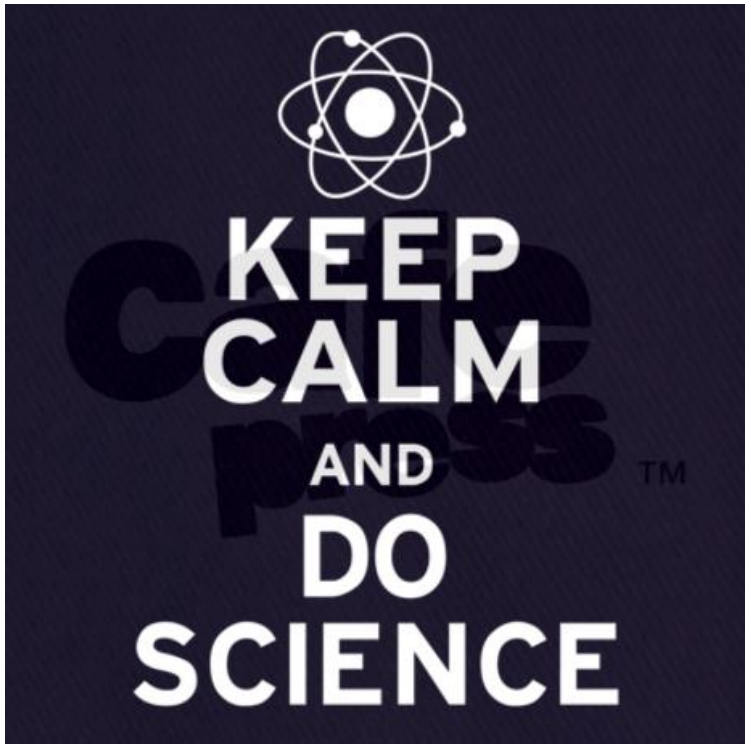
FACTORS THAT INFLUENCE VOIDING FOR VIA-IN-PAD DESIGNS



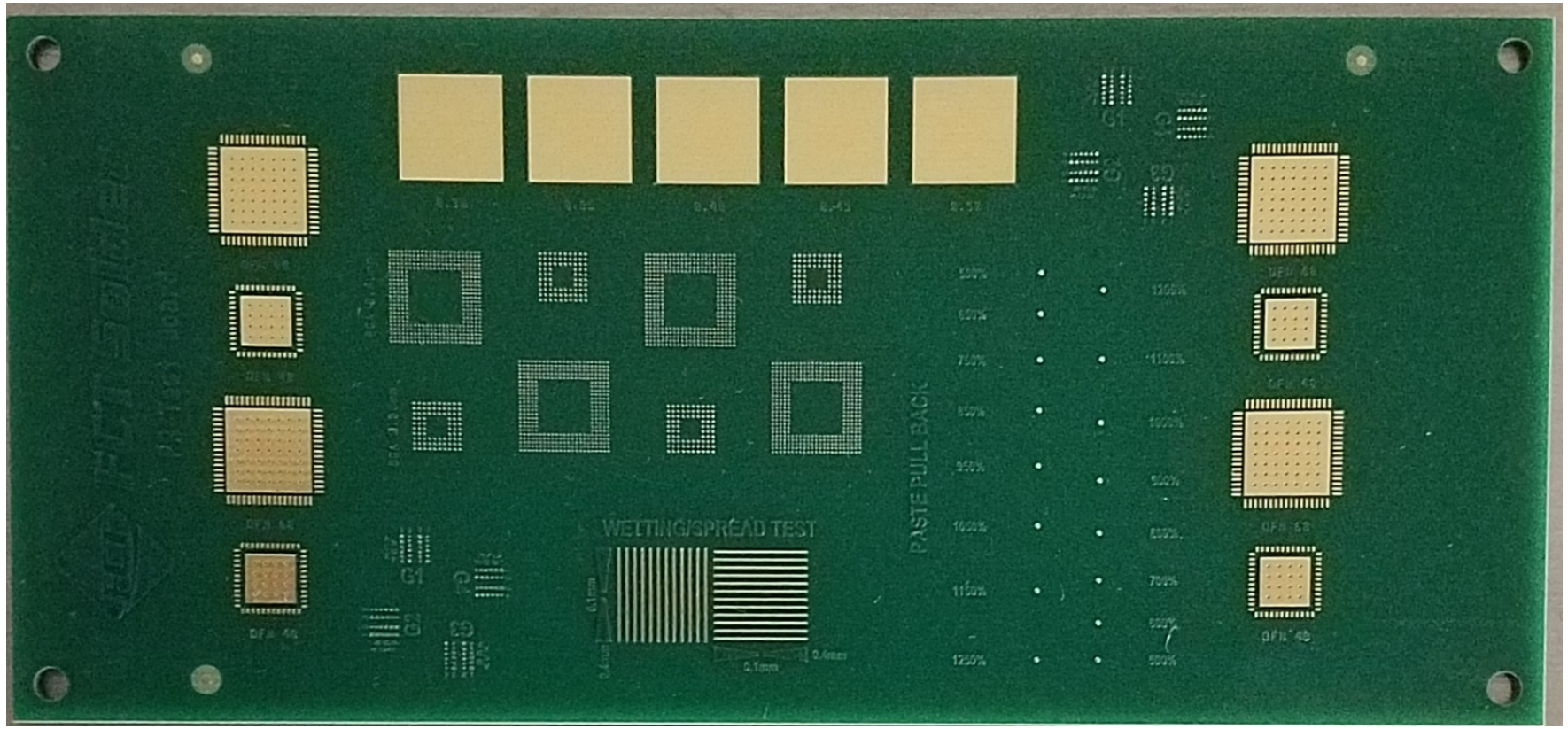


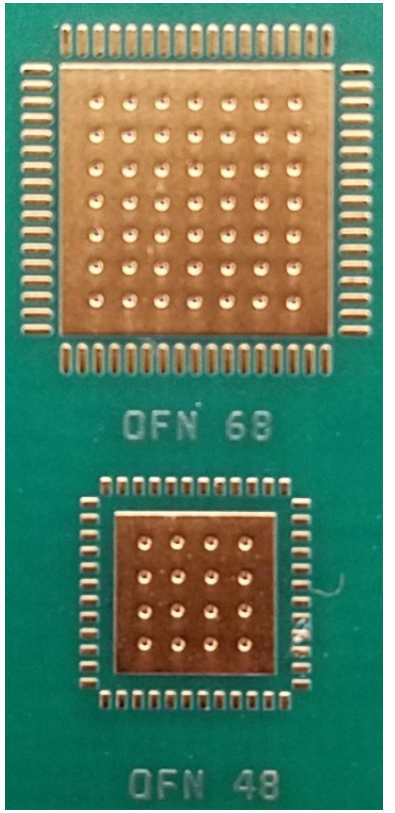
Solder Paste Print Options: Print over Vias, Print around Vias

METHODOLOGY



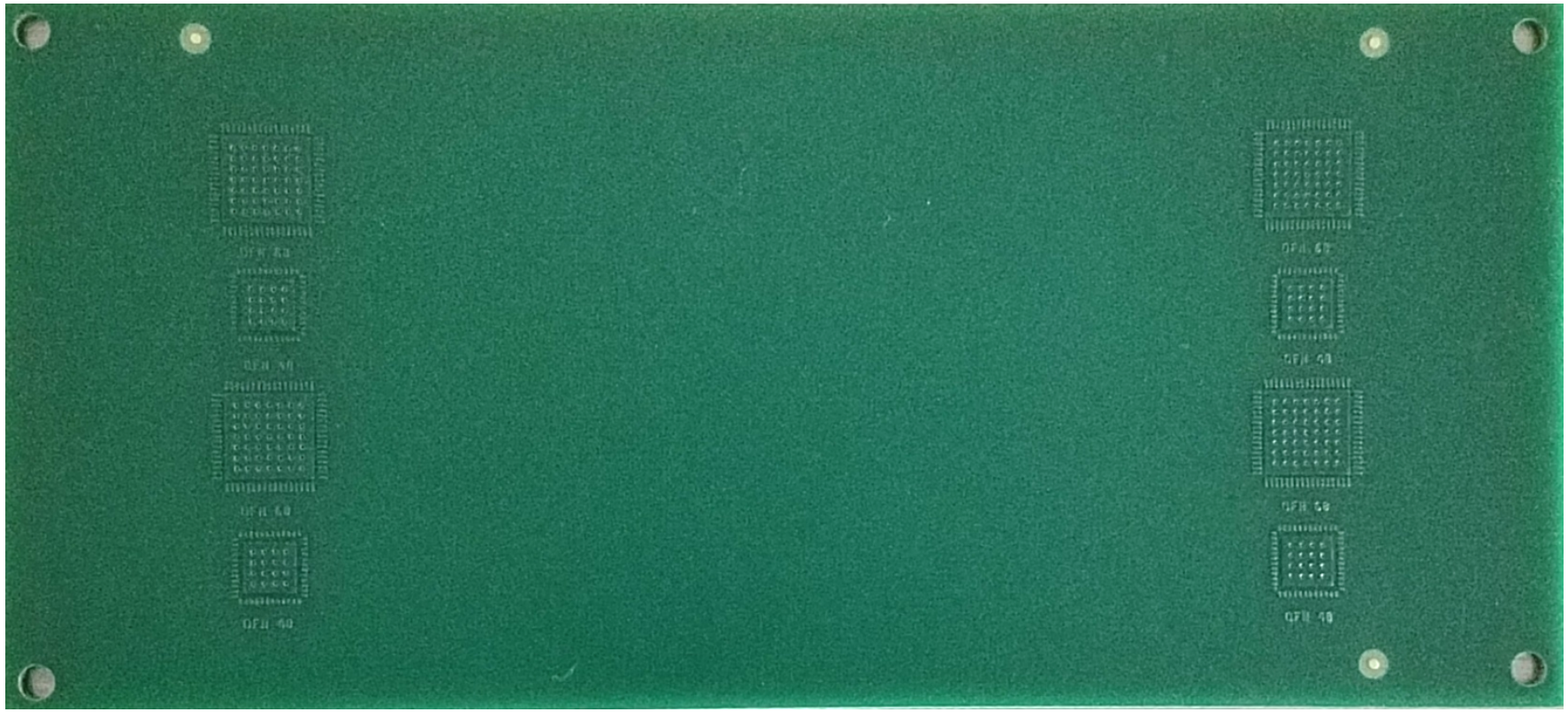
METHODOLOGY – CIRCUIT BOARDS

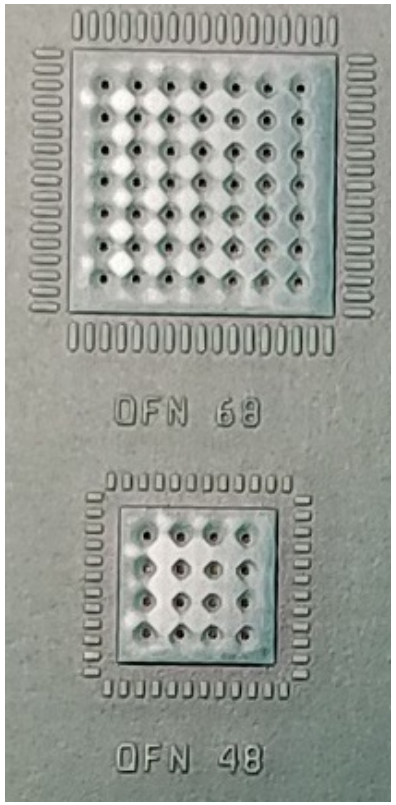




PR Test Board with Via in Pad (0.3 mm = 12 mil vias), Plated with ENIG

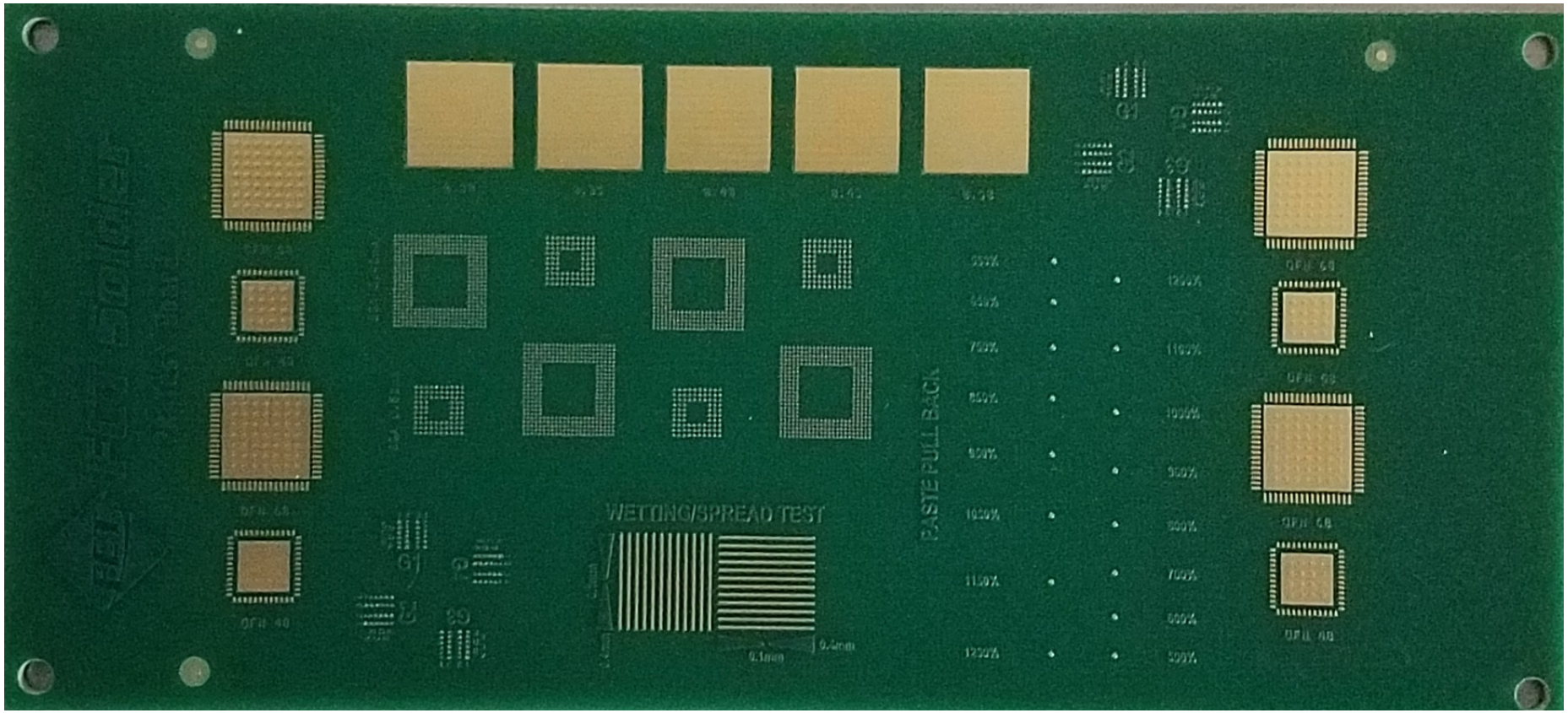
METHODOLOGY – CIRCUIT BOARDS

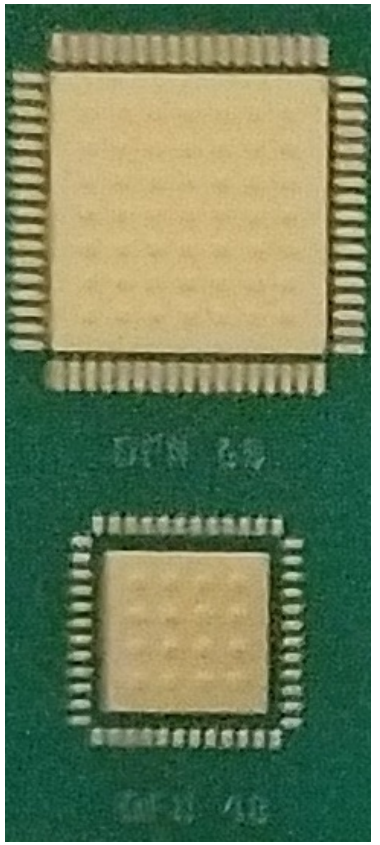




PR Test Board with a Solder Mask Tent on the Bottom Side

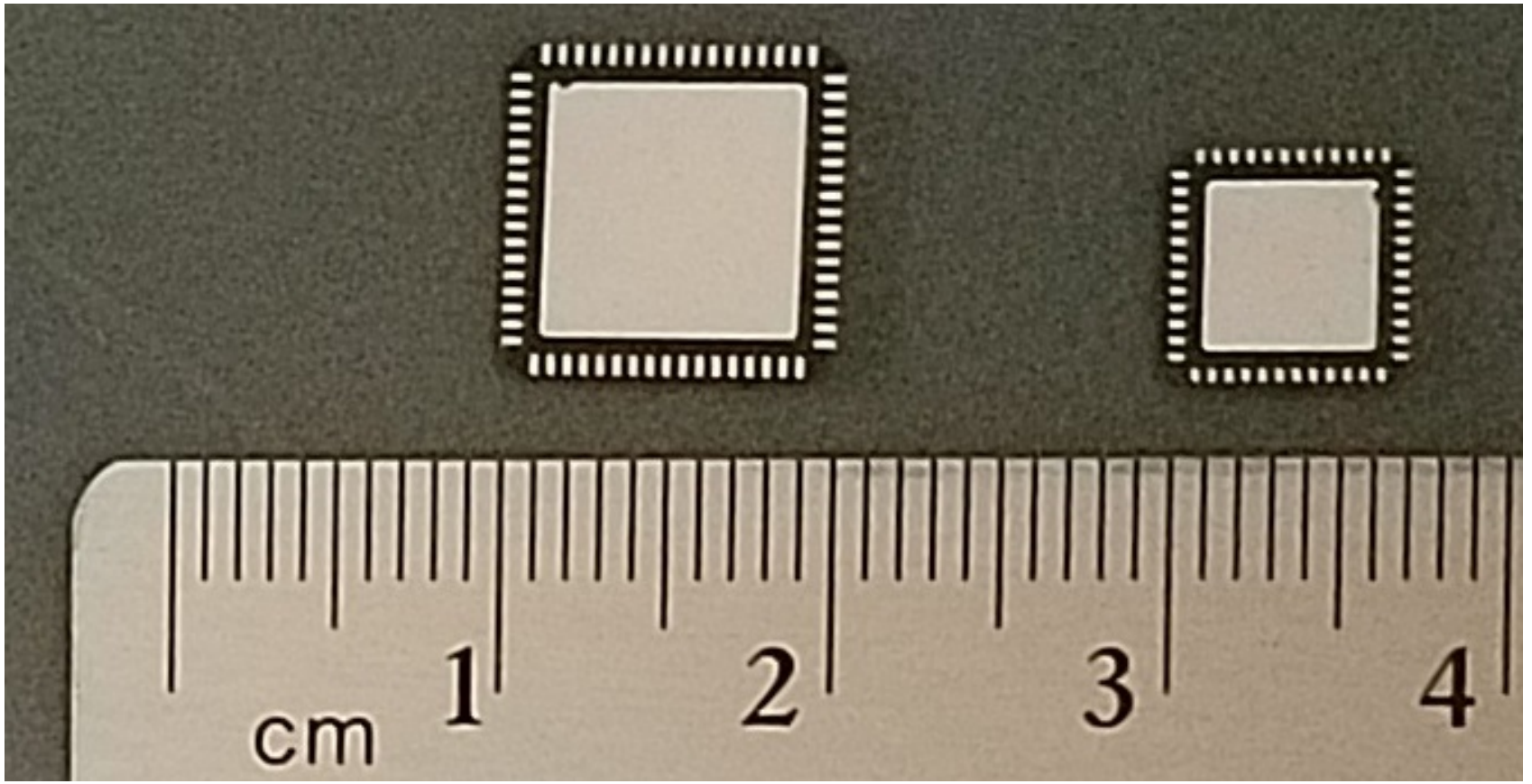
METHODOLOGY – CIRCUIT BOARDS





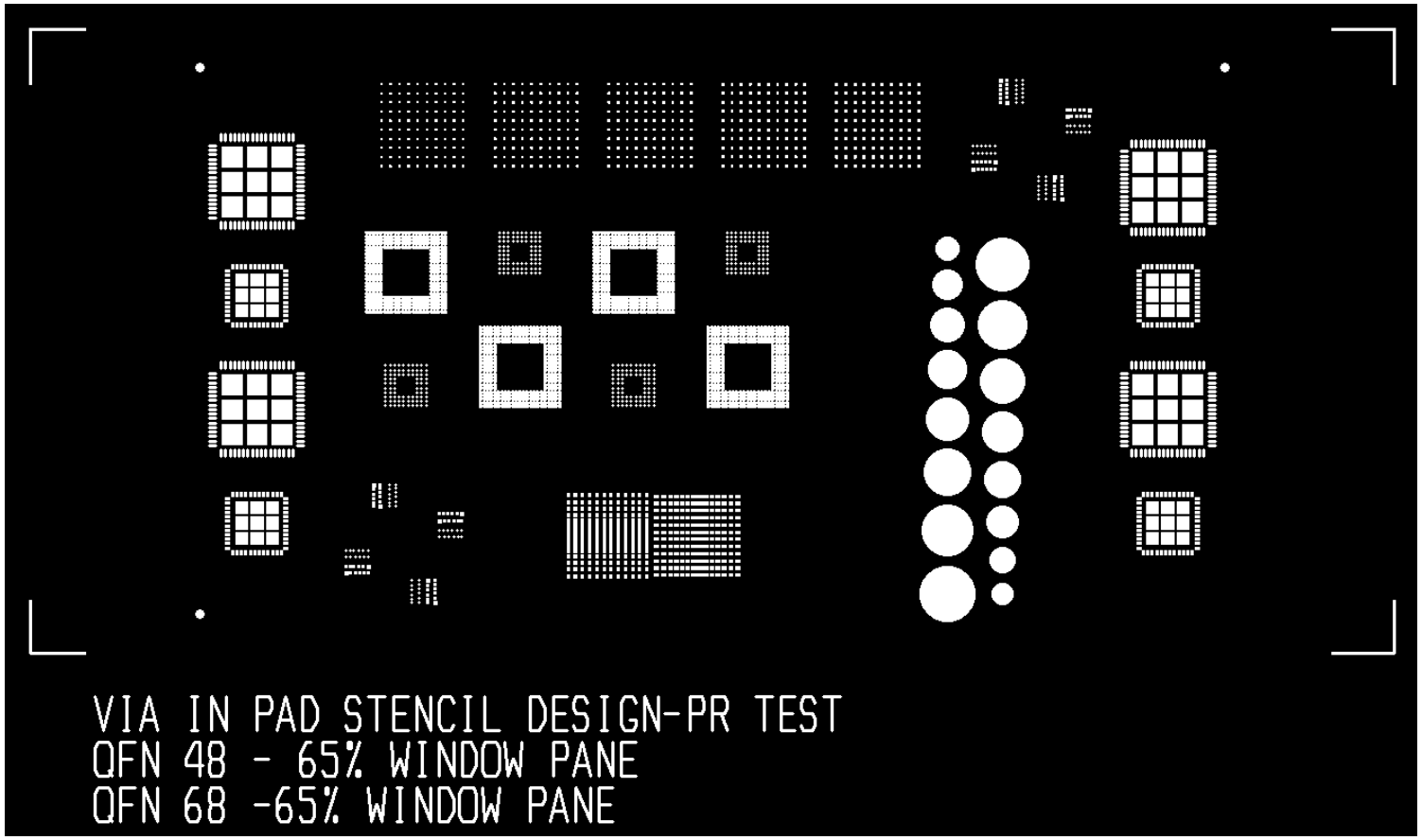
PR Test Board with Non-Conductive Via Fill, Plated with Cu and ENIG

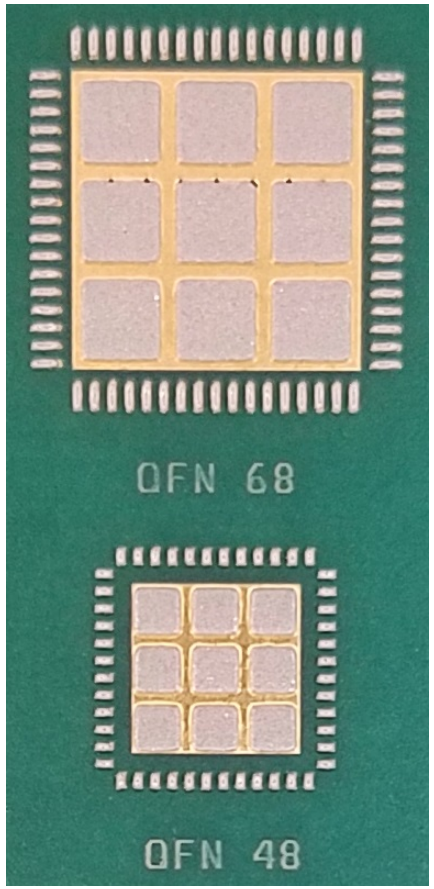
METHODOLOGY – QFN COMPONENTS



QFN Components: 10 mm body (68 lead) and 7 mm body (48 lead). Matte Tin Finish

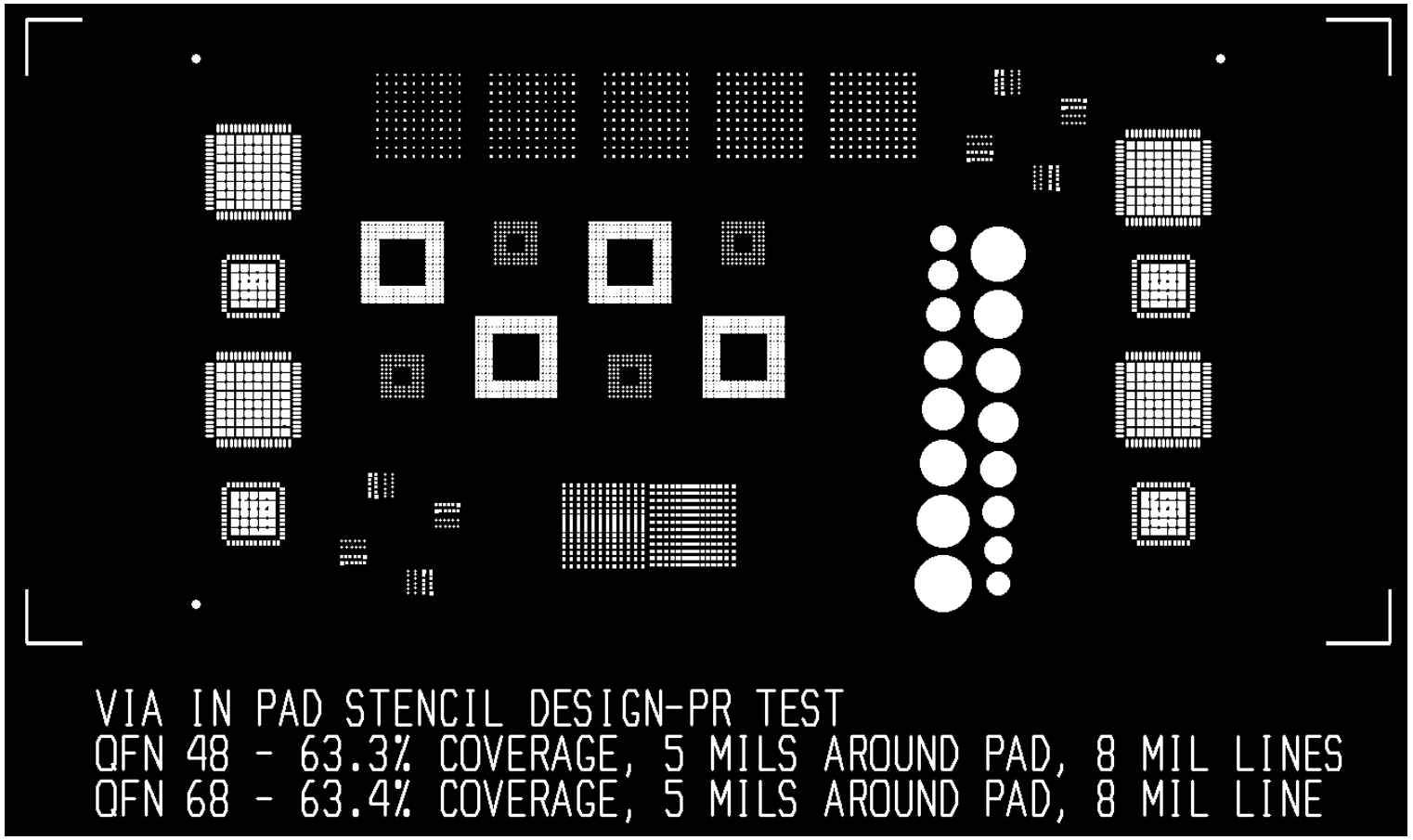
METHODOLOGY – STANDARD STENCIL

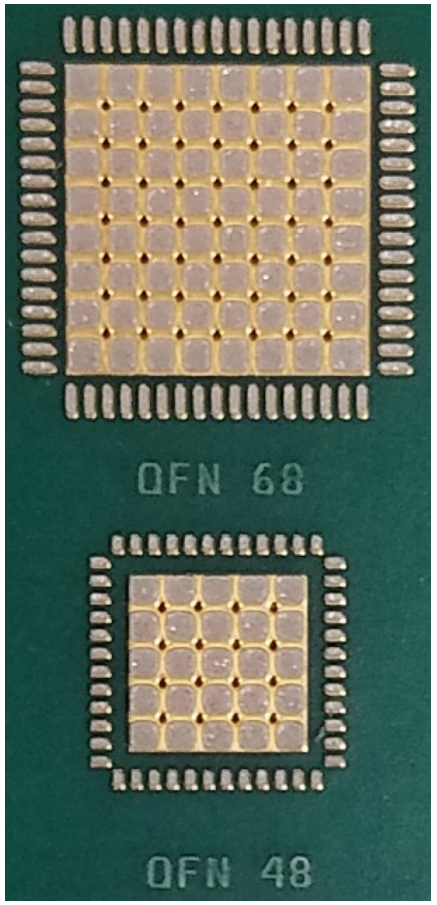




Standard Solder Paste Print: 65% Area Window Pane. Printed Over Via Holes

METHODOLOGY – MODIFIED STENCIL

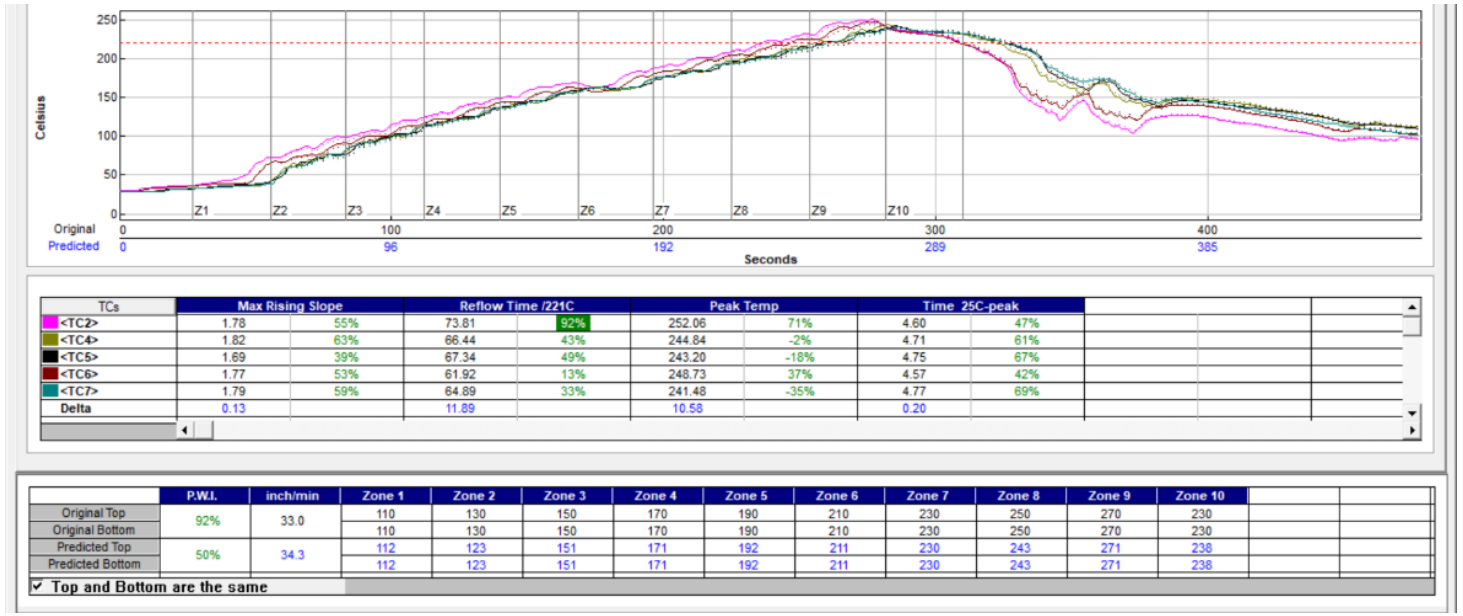




Modified Solder Paste Print: 63% Area Grid. Printed Around Via Holes

METHODOLOGY – SOLDER PASTE AND REFLOW

No Clean SAC305 Type 3 Solder Paste



TCs	Max Rising Slope		Reflow Time /221C		Peak Temp		Time 25C-peak	
<TC2>	1.78	55%	73.81	92%	252.06	71%	4.60	47%
<TC4>	1.82	63%	66.44	43%	244.84	-2%	4.71	61%
<TC5>	1.69	39%	67.34	49%	243.20	-18%	4.75	67%
<TC6>	1.77	53%	61.92	13%	248.73	37%	4.57	42%
<TC7>	1.79	59%	64.89	33%	241.48	-35%	4.77	69%
Delta	0.13		11.89		10.58		0.20	

	P.W.I.	inch/min	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Original Top	92%	33.0	110	130	150	170	190	210	230	250	270	230
Original Bottom			110	130	150	170	190	210	230	250	270	230
Predicted Top	50%	34.3	112	123	151	171	192	211	230	243	271	238
Predicted Bottom			112	123	151	171	192	211	230	243	271	238

☑ Top and Bottom are the same

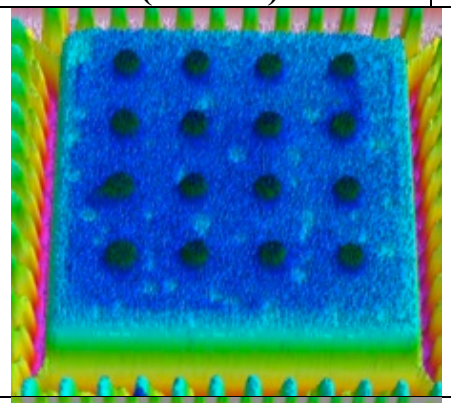
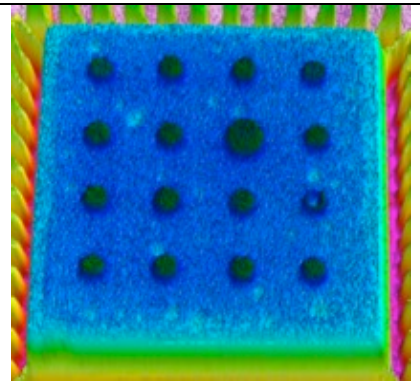
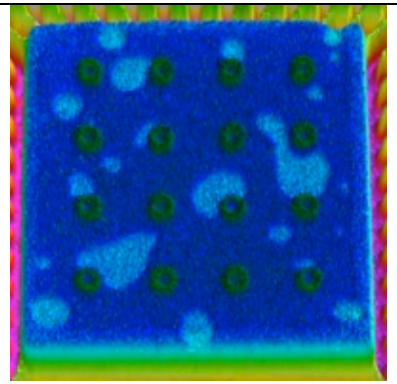
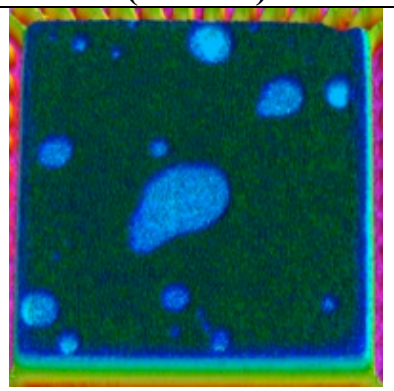
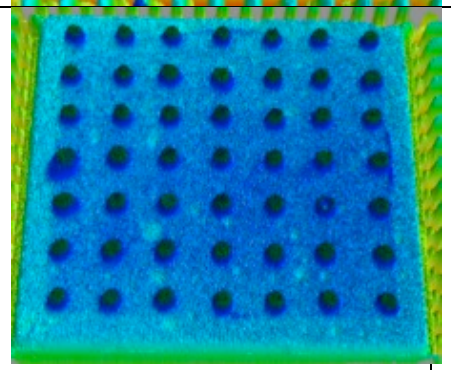
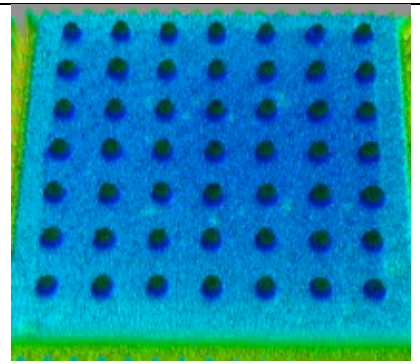
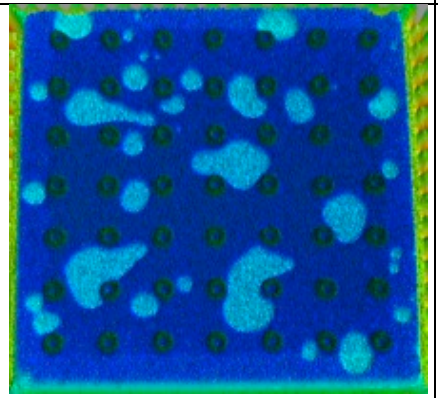
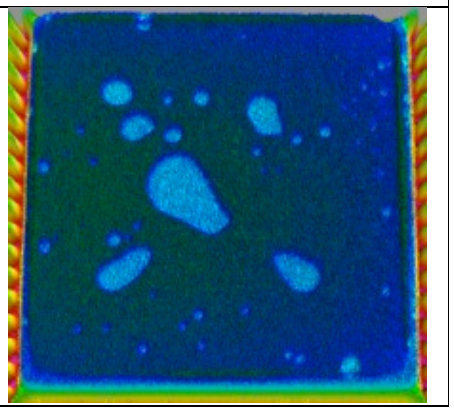
Setting	RTS Profile
Ramp rate	1.7 – 1.8 °C/sec
Reflow Time (> 220 °C)	61 – 67 sec
Peak temperature	241 to 248 °C
Profile length (25 °C to peak)	4.70 minutes

METHODOLOGY – EXPERIMENTAL PROCEDURE

- 10 Circuit Boards For Each Variation
- 4 of Each QFN Size Placed and Boards were Reflowed
- Void Area and Largest Size Measured on Each QFN
- Images were Taken of Representative QFN Voiding
- Data was Analyzed and Statistics Generated

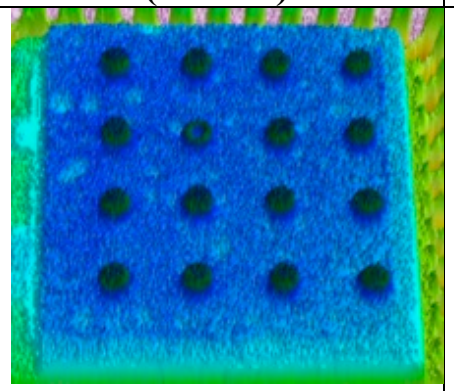
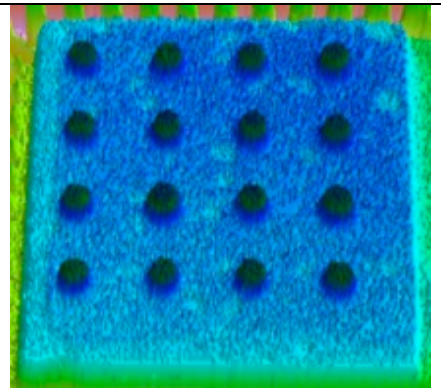
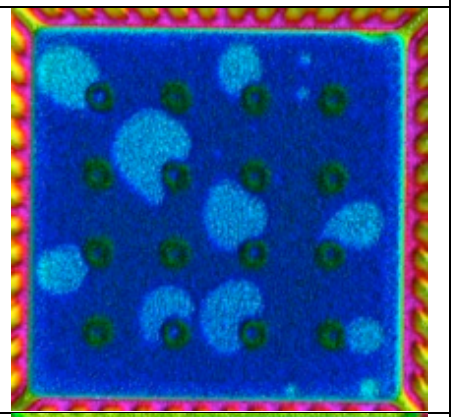
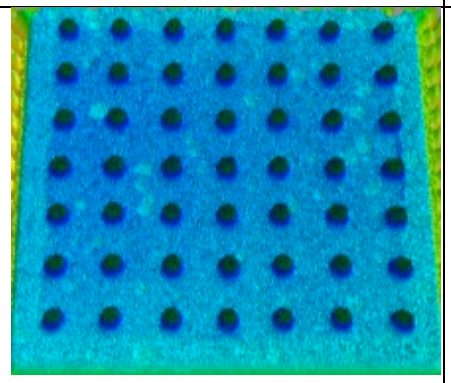
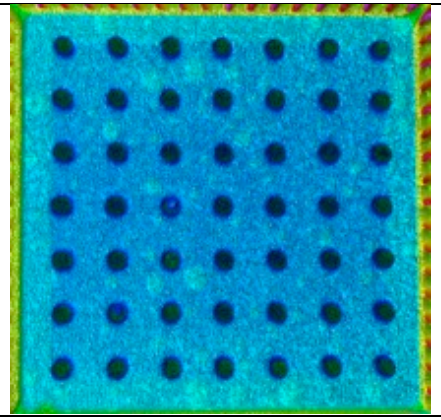
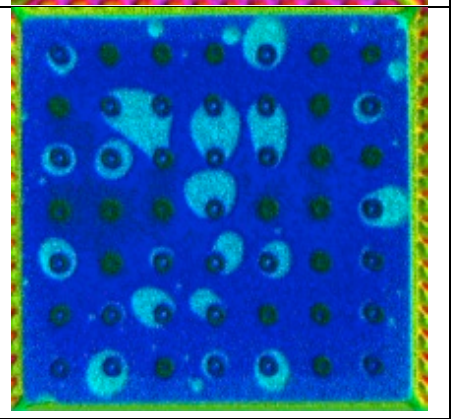
VOIDING RESULTS

VOIDING RESULTS – VIA FILL OPTIONS, STANDARD STENCIL

	Open Vias (No Fill)	Solder Mask Tent	Complete Plug	Flat Thermal Pad (No Via)
QFN7				
QFN10				

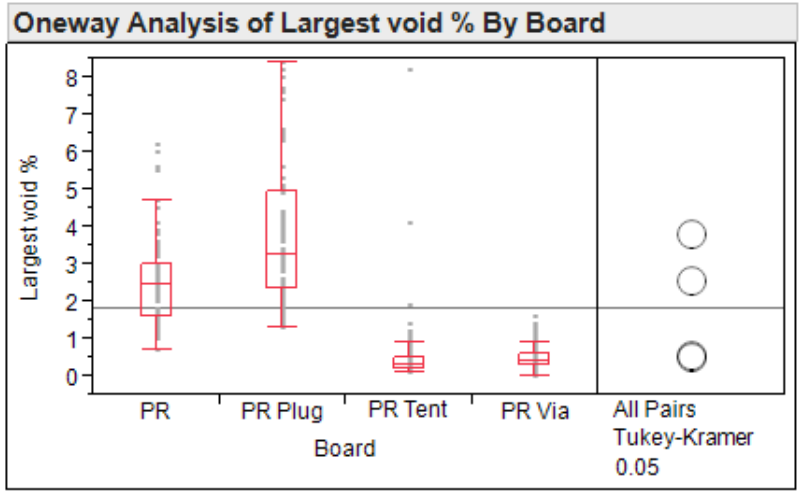
3D Voiding Images: Open Vias = Lower Voiding, Plugged and No Vias = More Voiding

VOIDING RESULTS – VIA FILL OPTIONS, MODIFIED STENCIL

	Open Vias (No Fill)	Solder Mask Tent	Complete Plug
QFN7			
QFN10			

3D Voiding Images: Open Vias = Lower Voiding, Plugged Vias = More Voiding

VOIDING SIZE – BY STENCIL



Excluded Rows 400

Means Comparisons

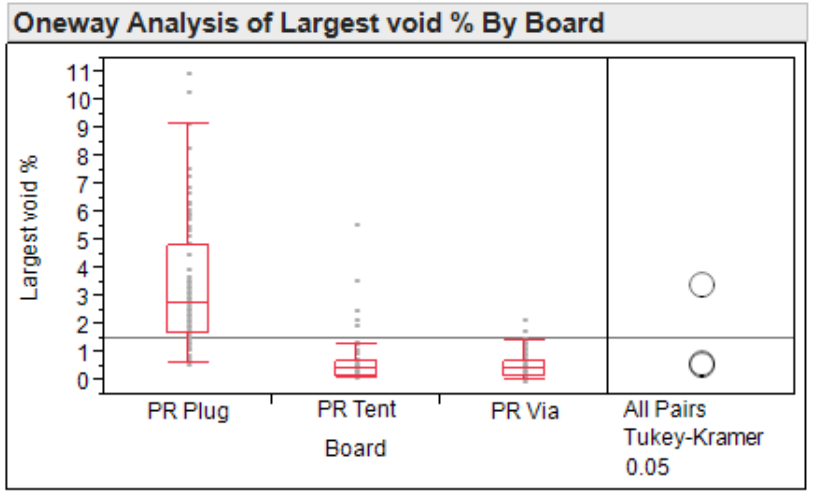
Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level		Mean
PR Plug	A	3.8162500
PR	B	2.5537500
PR Tent	C	0.5500000
PR Via	C	0.4762500

Levels not connected by same letter are significantly different.

STANDARD STENCIL



Excluded Rows 480

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

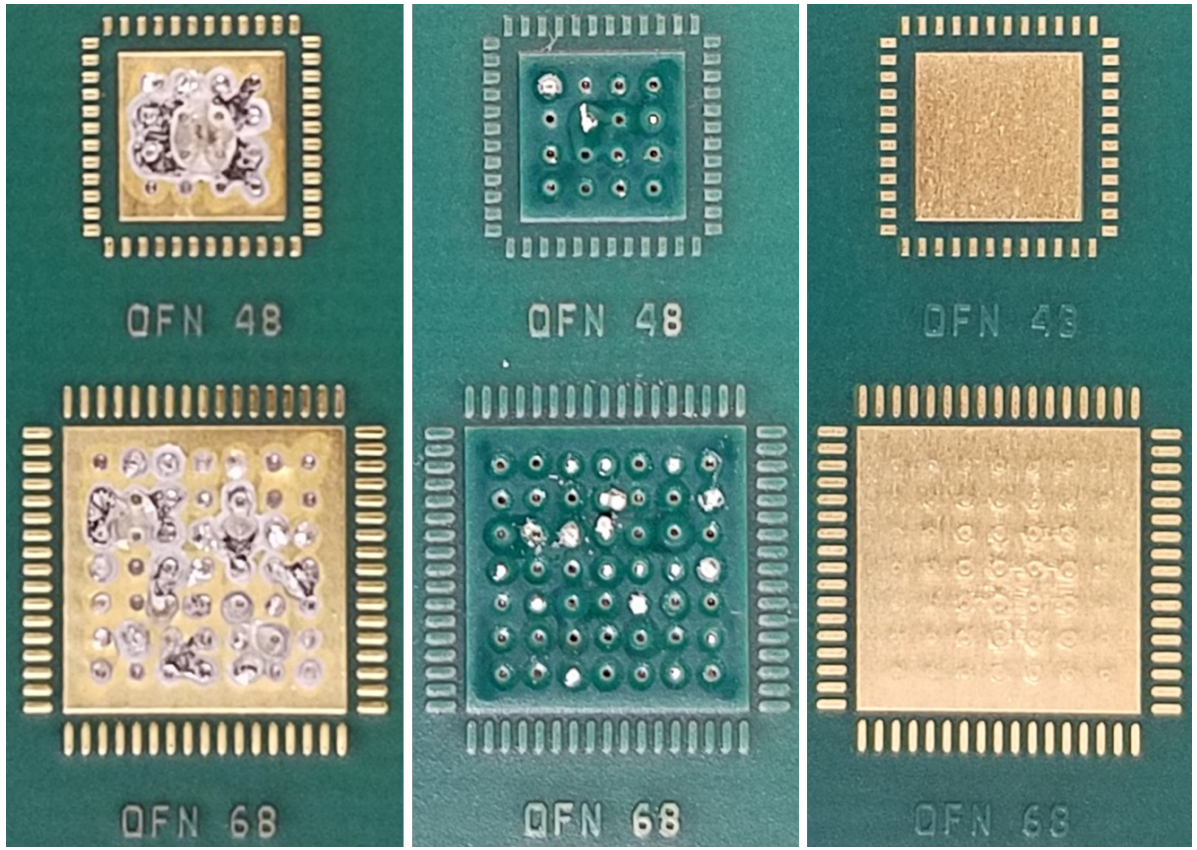
Level		Mean
PR Plug	A	3.4425000
PR Tent	B	0.6375000
PR Via	B	0.5575000

Levels not connected by same letter are significantly different.

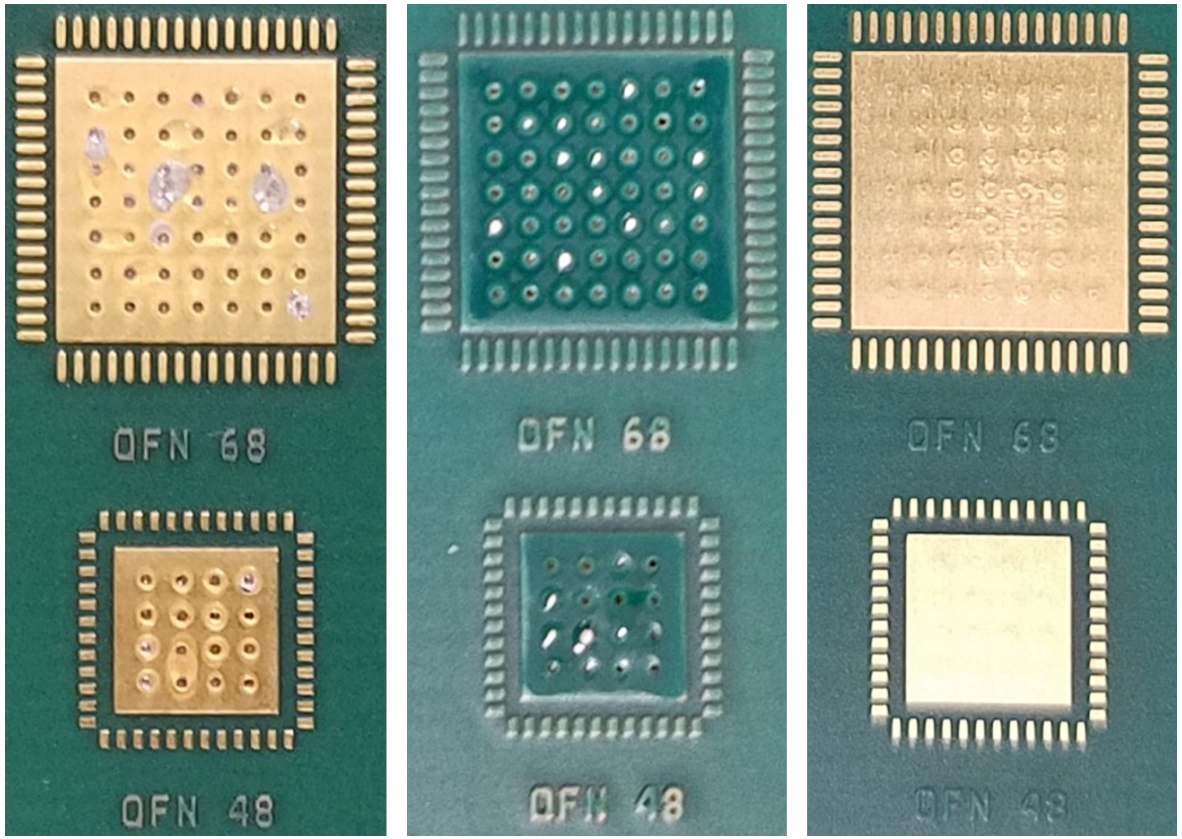
MODIFIED STENCIL

PR = Flat Pad (No Vias)
PR Plug = Plugged Vias
PR Tent = S/M Tented Vias
PR Via = Open Vias

SOLDER FLOW TO THE BOTTOM OF THE BOARD

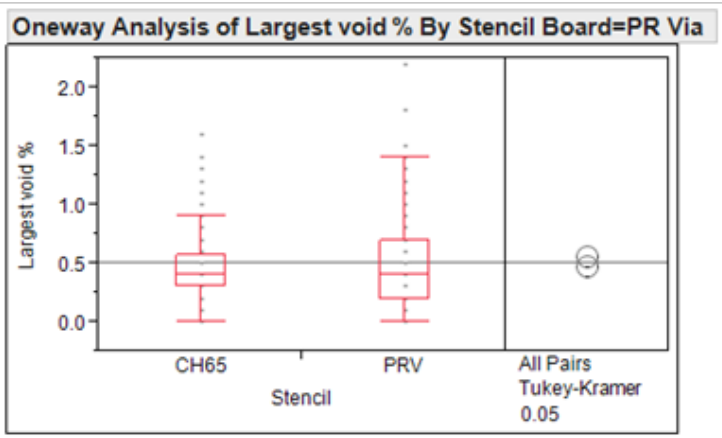


STANDARD STENCIL



MODIFIED STENCIL

VOIDING SIZE BY STENCIL DESIGN FOR EACH VIA TYPE



Excluded Rows 80

Means Comparisons

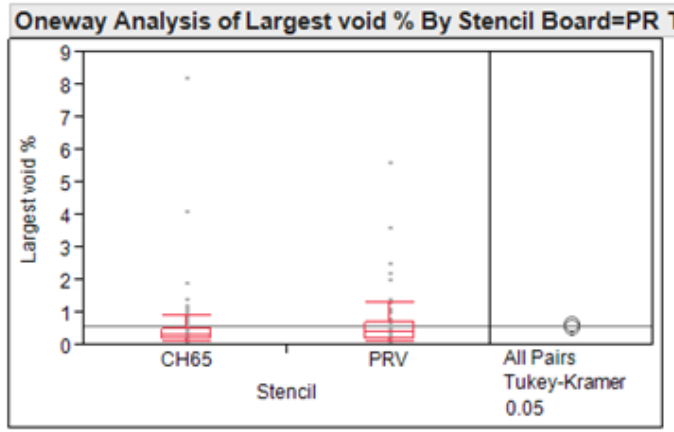
Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level		Mean
PRV	A	0.55750000
CH65	A	0.47625000

Levels not connected by same letter are significantly different.

OPEN VIAS



Means Comparisons

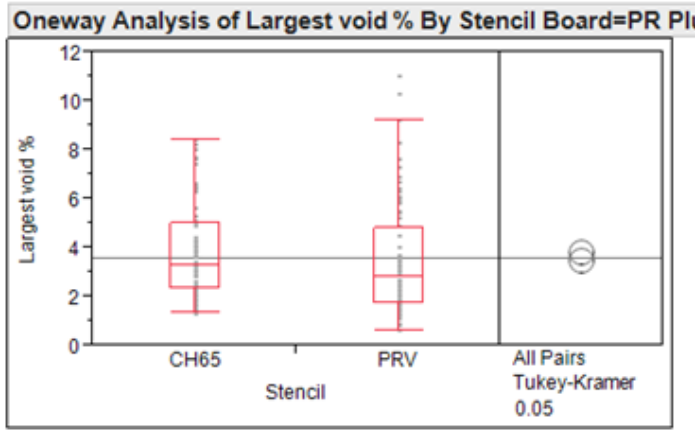
Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level		Mean
PRV	A	0.63750000
CH65	A	0.55000000

Levels not connected by same letter are significantly different.

TENTED VIAS



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

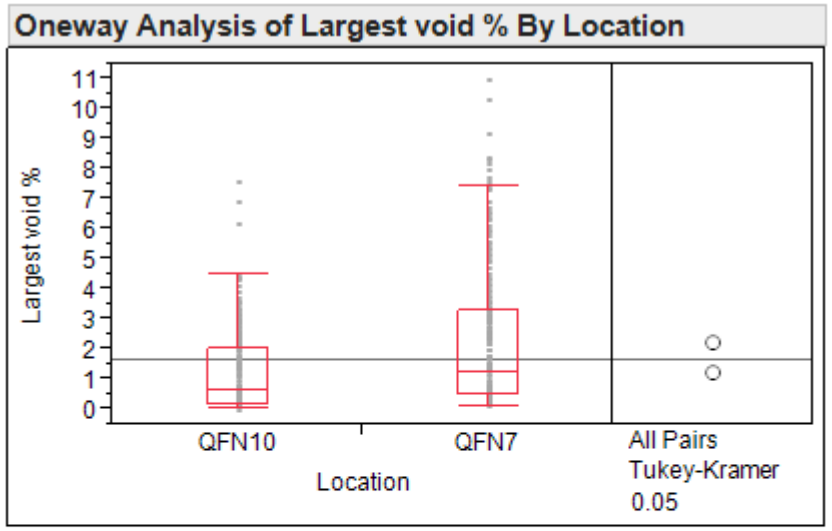
Connecting Letters Report

Level		Mean
CH65	A	3.8162500
PRV	A	3.4425000

Levels not connected by same letter are significantly different.

PLUGGED VIAS

VOIDING BY QFN SIZE



Excluded Rows 160

Means Comparisons

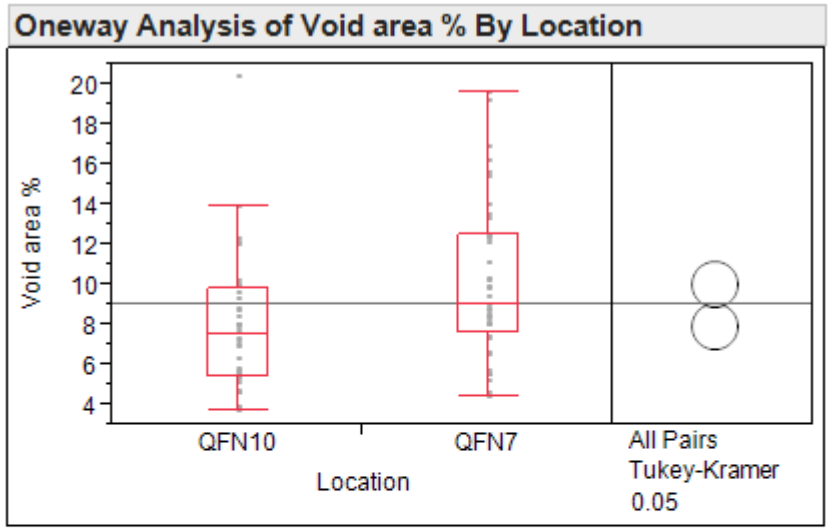
Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level		Mean
QFN7	A	2.2310714
QFN10	B	1.2071429

Levels not connected by same letter are significantly different.

LARGEST VOID SIZE



Excluded Rows 640

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level		Mean
QFN7	A	10.130000
QFN10	B	7.995000

Levels not connected by same letter are significantly different.

VOID AREA

Standard Stencil (65%)
Flat QFN Pads – No Vias
QFN10 Mass = 2x QFN7

FILL THE VOID

RECOMMENDATIONS TO FILL THE VOID

- Void size can be reduced using via holes in QFN thermal pads.
- Modifications to the stencil design limits the amount of solder flow through the via holes.
- Use of larger QFN's may reduce overall voiding.

Via holes in QFN thermal pads certainly influence voiding!

FUTURE WORK

Work on mitigation strategies to reduce voiding is ongoing.

Data will be presented at future technical conferences.

ACKNOWLEDGEMENTS

Greg Smith with BlueRing Stencils designed and supplied the stencils used in this work.

Tony Lentz

FCT Assembly

tlentz@fctassembly.com