FILL THE VOID VIII “THE OCHO”: CAN REFLOW PROFILES REALLY IMPROVE VOIDING IN SOLDER JOINTS?

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ABSTRACT

Voiding in solder joints remains a concern for manufacturers of printed circuit board assemblies (PCBAs). High voiding levels may lead to electrical, thermal, or mechanical failures. In some cases, challenging void limits are established as a “safety factor” to avoid the potential of failures. Low voiding limits create the need for methods of reduction of voiding in solder joints.

This work investigates reflow profiling which is a popular method of influencing void formation. Reflow profiles are easily changed and are expected to influence void behavior. The question is “can reflow profiles really improve voiding in solder joints?” Several no-clean SAC305 solder pastes were tested with multiple reflow conditions and voiding measured in QFN thermal pads. The PCBAs were reflowed a 2nd time and voiding evaluated to determine the effects of 2nd side reflow on voiding. The results were summarized and recommendations made to “Fill the Void.”

Key words: voids, reflow profile, solder paste, solder joints.

INTRODUCTION

Voiding in solder joints has been researched for many years, and the limits keep tightening, resulting in a need for methods to reduce voiding. Solder paste formulations have been developed to reduce voiding potential. Many solder paste print and reflow process parameters have been tested with respect to voiding potential. Reflow equipment has been developed with vacuum to reduce voiding in solder joints. When reduction of voiding below the established limits proves difficult, then a combination of void reduction strategies may be employed. This can include modification of PCBA design, change of the printed solder paste volume and location, adjustment of reflow profile parameters and/or equipment, use of solder preforms, and changing the solder paste used in the process. Rework of voids in solder joints is not always effective therefore mitigation strategies focus on prevention of voiding.

This work focuses on use of different reflow profiles with a variety of no-clean SAC305 solder pastes to determine the effects on voiding in solder joints. Furthermore, voiding in the 1st side solder joints tends to change during 2nd side PCBA reflow. This work also examines the effects of 2nd side reflow on the voiding in the 1st side solder joints. Recommendations are made to reduce voiding potential in solder joints.

PRIOR WORK

T. Lentz, P. Chonis, and JB. Byers [1] studied methods of reducing voiding in solder joints. Five different solder pastes were tested including three water-soluble SAC305 and two no-clean SAC305 solder pastes. One of the water-soluble solder pastes was tested with various reflow profiles and a ramp-soak-spike (RSS) profile was shown to give statistically higher voiding than a ramp-to-spike (RTS) profile. The voiding was reduced significantly by reflow in vapor phase (oxygen free) for this same water-soluble solder paste. Vacuum applied during reflow further reduced voiding to near zero levels regardless of the reflow profile for this same water-soluble solder paste.

T. Lentz [2] studied the effects of surface finish on solder paste performance including voiding in solder joints. A water-soluble SAC305 solder paste and a no-clean SAC305 solder paste were reflowed in RSS and RTS reflow profiles, and voiding compared. The no-clean solder paste showed similar voiding levels for both reflow profiles. The water-soluble solder paste gave higher voiding for the RTS profile and lower voiding for the RSS profile. Three PCB surface finishes were tested and they influenced voiding as well.

T. Lentz and G. Smith [3] studied methods for mitigating voiding for bottom terminated components. A low voiding no-clean SAC305 solder paste was used for this work along with 5 reflow profiles, and a host of stencil printed design variations. The reflow profiles varied soak time, reflow time, peak temperature, and overall length. The linear RTS profile gave the lowest overall voiding and was used for the remainder of the work. Stencil design was shown to have a large impact on voiding behavior.

T. Lentz [4] studied the impact of solder alloy on voiding in solder joints. Voiding was studied with the same no-clean solder paste flux and five different alloys including Sn63/Pb37 and Sn/Bi37/X lower temperature alloys. An RTS SAC305 reflow profile was compared to RTS profiles appropriate to the Sn63/Pb37 and Sn/Bi37/X lower temperature alloys. The voiding was reduced for these two alloys when run in the SAC305 profile as opposed to their normal lower temperature reflow profiles.

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N. Holle, T. Ewald, U. Welzel [5] gave an overview of voiding in solder joints from an industry perspective. Increasing peak reflow temperature reduced voiding in some cases, but very high peak temperatures do not reduce voiding significantly. It was noted that many other factors have a greater influence on voiding than reflow profile.

EXPERIMENTAL METHODOLOGY

This work studies the effects of reflow profiles on voiding with four no-clean Pb-free solder pastes made with SAC305 IPC Type 4 (20-38 µm) solder powder (Table 1). These solder pastes are commercially available, and they are halide and halogen free except for solder paste C. Solder paste C is halide-free but contains halogens.

Table 1. No-Clean SAC305 T4 Solder Pastes.

Solder Paste	Flux Class (IPC J-STD-004)	Metal Content (% wt)
A	ROL0	88.0
B	ROL0	88.3
C	ROL0 (Halogen containing)	87.9
D	ROL0	88.2

Voiding performance was measured using the PR test board (Figure 1) and the thermal pad solder joints of MLF68 quad-flat no-lead components (QFN). The PR test board is single sided and has an electroless nickel, immersion gold (ENIG) finish.

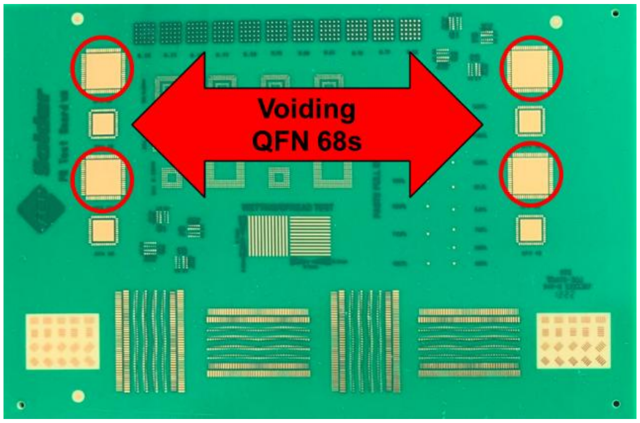


Figure 1. PR Test Board and Void Testing with QFN 68 Thermal Pads.

The stencil design in the QFN thermal pads was a standard 9 window pane design with 65% area of coverage of solder paste and 508 µm (20 mil) wide webs (Figure 2). The stencil was made from laser cut 127 µm (5 mil) thick fine grain (FG) stainless steel.

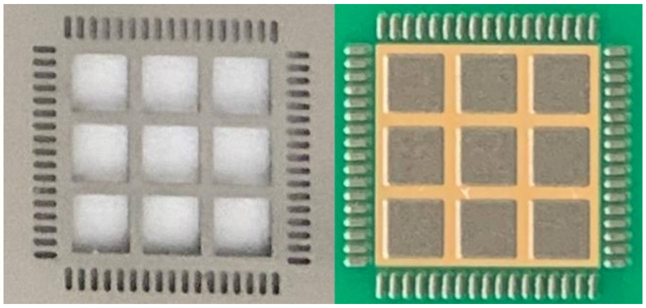


Figure 2. Solder Paste Printed on the QFN (MLF68) Thermal Pad.

Printing was done with a commercially available printer and the following print settings (Table 2).

Table 2. Printing Process Parameters.

Print Parameter	Value
Print speed (mm/sec)	30 mm/sec
Blade angle (deg.)	60°
Blade length (mm)	300 mm
Print pressure (kg)	5.0 Kg
Separation speed (mm/sec)	3 mm/sec
Separation distance (mm)	2 mm

Underside stencil cleaning was not performed during this experiment.

Convection reflow was performed in a commercially available 7-zone oven in an air atmosphere. Five reflow profiles were created and the codes for the 5 reflow profiles are as follows:

- RTS = Ramp To Spike (Linear)
- RSS = Ramp Soak Spike (Soak)
- LPSR = Low Peak, Short Reflow time
- LPLR = Low Peak, Long Reflow time
- LSHPLR = Long Soak, High Peak, Long Reflow time

These reflow profiles represent commonly used profiles in the industry, and push some of the recommended reflow parameters to their high and low values. The reflow profile graphs are shown below (Figure 3).

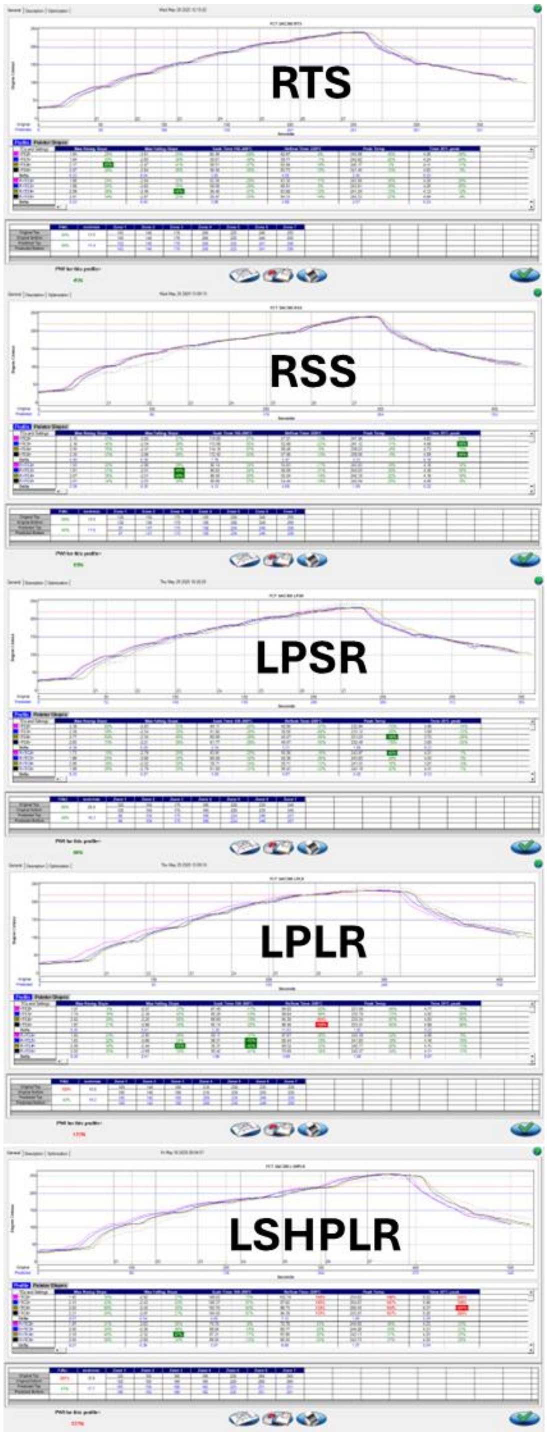


Figure 3. Reflow Profile Graphs.

The recorded values for the reflow profiles are summarized below (Table 3).

Table 3. Measured SAC305 Reflow Profile Parameters.

Parameter	RTS	RSS	LPSR	LPLR	LSHPLR
Soak time 150-200°C (sec)	58-62	112-114	62-64	65-67	104-109
Peak temp (°C)	240-243	239-242	231-233	232-233	255-256
Reflow Time >220°C (sec)	60-64	53-58	40-45	85-96	98-103
Time from 25°C to Peak Temp (min)	4.0-4.3	4.7-4.9	3.6-3.9	4.8-5.0	6.0-6.3

Voiding was measured using 2D X-ray inspection of the thermal pad solder joints of MLF68 QFN components. 20 void area % measurements were taken for each solder paste and reflow profile combination. Voiding was measured after the 1st side reflow for every solder paste & reflow profile combination. The PCBAs were reflowed a 2nd time in same reflow profile as the 1st reflow and voiding was measured again. This was done to determine the effects of 2nd side reflow on the voids within the 1st side solder joints. The reflow profile codes in the data sets were modified to indicate voiding after 2 reflows by appending a number “2” to the end of the code. For example, the RTS profile after 2 reflows was assigned the code “RTS2”.

The void data was placed into a table and statistical analysis software was used to determine differences in the void data. Tukey Kramer Honest Significant Difference (HSD) testing was conducted with a 95% confidence level. Trends and differences in voiding were observed and noted.

The process used to create the PCBAs and measure voiding is shown below (Figure 4).

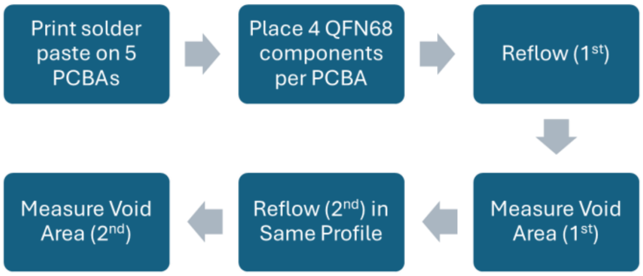


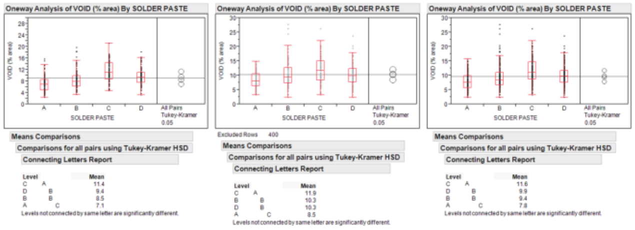
Figure 4. Process Used to Create the PCBAs and Measure Voiding.

This process was repeated for 4 solder pastes and 5 reflow profiles with each solder paste. This gave a total of 20 combinations of solder paste and reflow profile. For each combination of solder paste and reflow profile, 20 QFNs were placed, and 20 void measurements were taken. The total number of data points per combination was 20 for the 1st reflow and an additional 20 for the 2nd reflow.

RESULTS AND DISCUSSION

Voiding by Solder Paste

The void data broken out by solder paste is shown below with all the profiles averaged together (Figure 5). Voiding of the solder pastes is shown after the 1st reflow only, 2nd reflow only, and both reflows grouped together.



Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
C	A	11.4
D	B	9.4
B	B	8.5
A	C	7.1

Levels not connected by same letter are significantly different.

Excluded Rows 400

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
C	A	11.9
B	B	10.3
D	B	10.3
A	C	8.5

Levels not connected by same letter are significantly different.

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
C	A	11.6
D	B	9.9
B	B	9.4
A	C	7.8

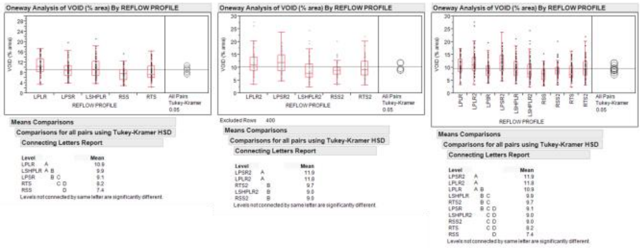
Levels not connected by same letter are significantly different.

Figure 5. Voiding by Solder Paste: 1st Reflow (Left), 2nd Reflow (Center), Both Reflows (Right).

The voiding by solder paste is the same regardless of number of profiles, with all the profiles averaged together. Solder paste C gave the highest overall voiding, followed by B and D which gave similar moderate voiding levels. Solder paste A gave the overall lowest voiding.

Voiding by Reflow Profile

The void data broken out by reflow profile is shown below with all the solder pastes averaged together (Figure 6). Voiding of the reflow profiles is shown after the 1st reflow only, 2nd reflow only, and both reflows grouped together.



Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
LPLR	A	10.9
LSHPLR	A B	9.9
LPSR	B C	9.1
RTS	C D	8.2
RSS	D	7.4

Levels not connected by same letter are significantly different.

Excluded Rows 400

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
LPSR2	A	11.9
LPLR2	A	11.8
RTS2	B	9.7
LSHPLR2	B	9.0
RSS2	B	9.0

Levels not connected by same letter are significantly different.

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
LPSR2	A	11.9
LPLR2	A	11.8
LPLR	A B	10.9
LSHPLR	B C	9.9
RTS2	B C	9.7
LPSR	B C D	9.1
LSHPLR2	C D	9.0
RSS2	C D	9.0
RTS	C D	8.2
RSS	D	7.4

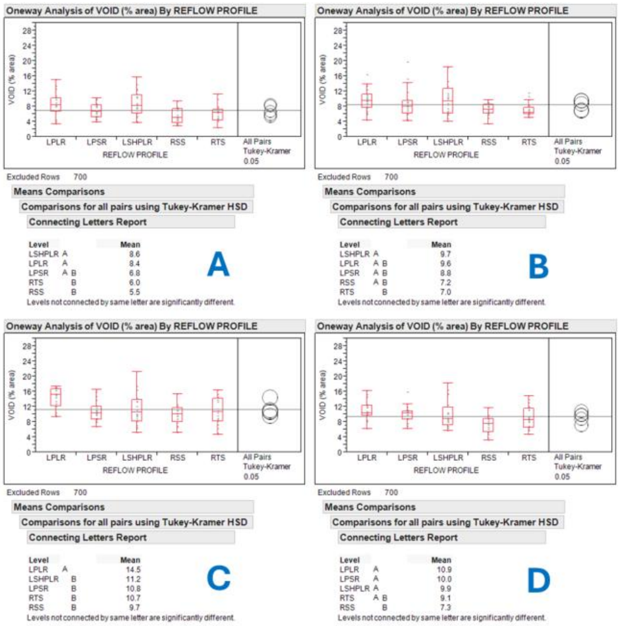
Levels not connected by same letter are significantly different.

Figure 6. Voiding by Reflow Profile: 1st Reflow (Left), 2nd Reflow (Center), Both Reflows (Right).

After 1 reflow, voiding was highest for the LPLR and LSHPLR profiles followed by the LPSR and RTS profiles. The RSS profile gave the lowest overall voiding with some overlap to the RTS profile. After 2 reflows, the order of voiding changed a little. The LPSR and LPLR profiles gave the highest overall voiding, and all the other profiles gave similarly lower voiding. When ranking all the 1st and 2nd reflows in the same chart, the LP (low peak) profiles tended to give higher voiding, and the standard RTS and RSS profiles gave the lowest overall voiding.

Voiding for Each Solder Paste by Reflow Profile

Voiding for each solder paste broken out by reflow profile after the 1st reflow is shown below (Figure 7).



Excluded Rows 700

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
LSHPLR	A	8.6
LPLR	A	8.4
LPSR	A B	6.8
RTS	B	6.0
RSS	B	5.5

Levels not connected by same letter are significantly different.

Excluded Rows 700

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
LSHPLR	A	9.7
LPLR	A B	9.6
LPSR	A B	8.8
RSS	A B	7.2
RTS	B	7.0

Levels not connected by same letter are significantly different.

Excluded Rows 700

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

Level		Mean
LPLR	A	14.5
LSHPLR	B	11.2
LPSR	B	10.8
RTS	B	10.7
RSS	B	9.7

Levels not connected by same letter are significantly different.

Excluded Rows 700

Means Comparisons
Comparisons for all pairs using Tukey-Kramer HSD
Connecting Letters Report

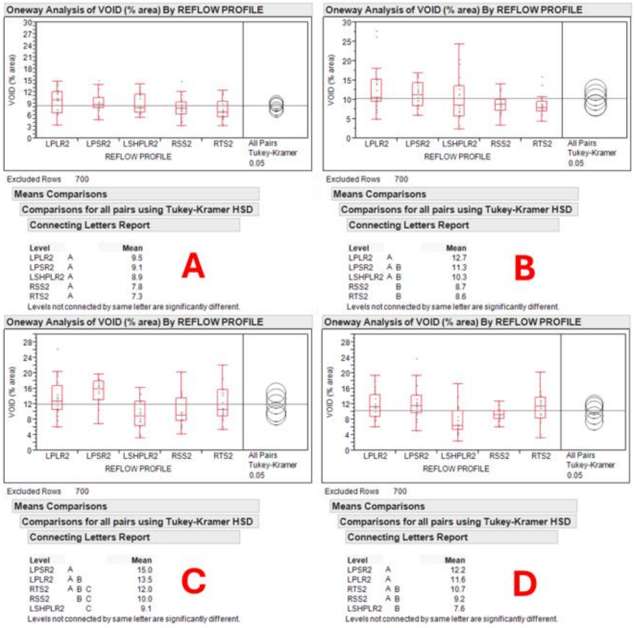
Level		Mean
LPLR	A	10.9
LPSR	A	10.0
LSHPLR	A	9.9
RTS	A B	9.1
RSS	B	7.3

Levels not connected by same letter are significantly different.

Figure 7. Voiding for Solder Pastes A, B, C and D for Each Reflow Profile After the 1st Reflow.

Solder paste A showed the highest voiding with the LSHPLR, LPLR, and LPSR profiles, and the lowest voiding with the RTS and RSS profiles. Solder paste B showed similar response to the profiles as solder paste A. Solder paste C gave the highest voiding with the LPLR profile and all the other profiles gave lower voiding. Solder paste D gave higher voiding with most of the profiles, but the RSS profile gave statistically lower voiding.

Voiding for each solder paste broken out by reflow profile after the 2nd reflow is shown below (Figure 8).



Excluded Rows 700

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level			Mean
LPLR2	A		9.5
LPSR2	A		9.1
LSHPLR2	A		8.9
RSS2	A		7.8
RTS2	A		7.3

Levels not connected by same letter are significantly different.

Excluded Rows 700

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level			Mean
LPLR2	A		12.7
LPSR2	A	B	11.3
LSHPLR2	A	B	10.3
RSS2		B	8.7
RTS2		B	8.6

Levels not connected by same letter are significantly different.

Excluded Rows 700

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level				Mean
LPSR2	A			15.0
LPLR2	A	B		13.5
RTS2	A	B	C	12.0
RSS2		B	C	10.0
LSHPLR2			C	9.1

Levels not connected by same letter are significantly different.

Excluded Rows 700

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level			Mean
LPSR2	A		12.2
LPLR2	A		11.6
RTS2	A	B	10.7
RSS2	A	B	9.2
LSHPLR2		B	7.6

Levels not connected by same letter are significantly different.

Figure 8. Voiding for Solder Pastes A, B, C and D for Each Reflow Profile After the 2nd Reflow.

Solder paste A showed equivalent voiding regardless of profile after the 2nd reflow. Solder paste B showed higher voiding for the LPLR profile and lower voiding for the RSS and RTS profiles while the other profiles were in the middle of the void rankings. Solder pastes C and D showed higher voiding for the LPSR and LPLR profiles and lower voiding for the LSHPLR profile, while the other profiles were in the middle.

Voiding for each solder paste by reflow profile including 1st and 2nd reflows is shown below (Figure 9).

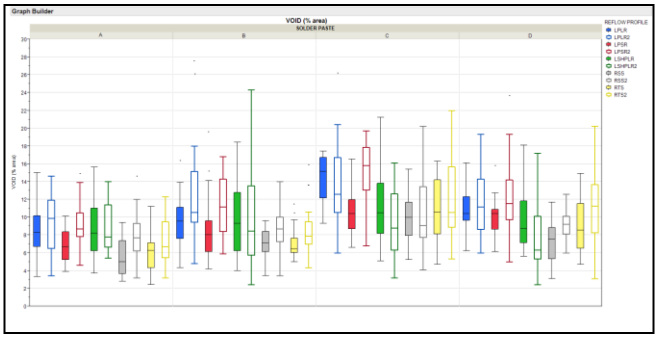


Figure 9. Voiding for Each Solder Paste by Profile. Solid Colored Boxes = 1st Reflow. Outline Boxes = 2nd Reflow.

The voiding for each solder paste varies by profile and in general the 2nd reflows (outline box plots) increased voiding over the 1st reflow of the same profile. The exception to this is the LSHPLR profile which showed lower voiding after the 2nd reflow for most of the solder pastes.

For solder paste A, the lowest voiding was achieved with the RSS, RTS, and LPSR profiles. For solder paste B, the lowest voiding was found with the RSS and RTS profiles. For solder paste C, the lowest voiding was achieved with the LPSR and RSS profiles. For solder paste D, the lowest voiding was found with the RSS profile. In general, the ramp-soak-spike (RSS) and ramp-to-spike (RTS) profiles gave lower voiding for this set of no-clean SAC305 solder pastes.

Voiding for Each Reflow Profile by Solder Paste

Voiding for each reflow profile by solder paste is shown below (Figure 10).

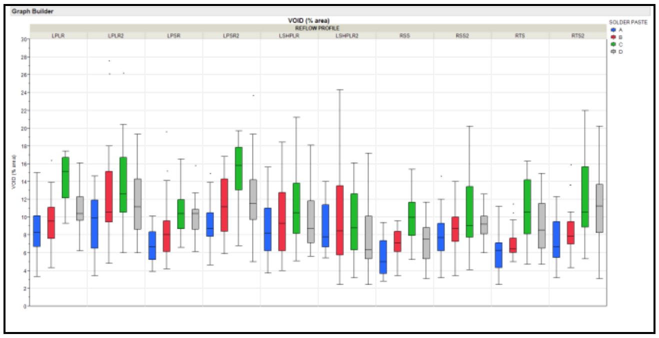
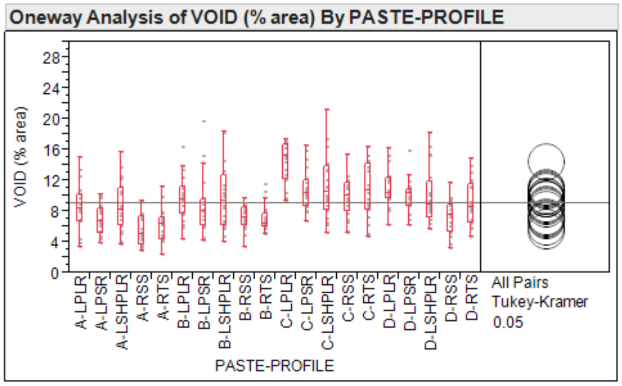


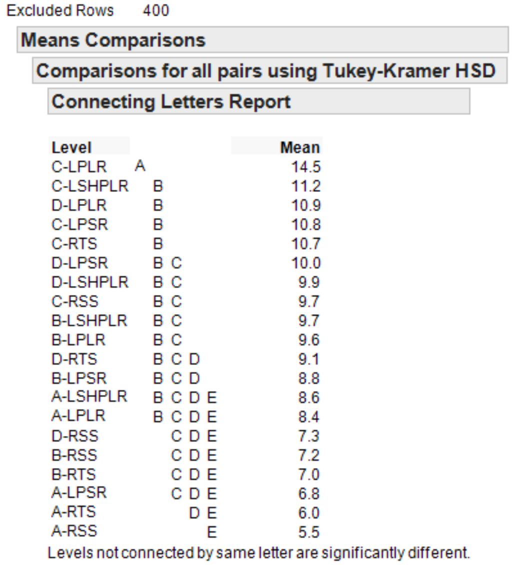
Figure 10. Voiding for Each Reflow Profile by Solder Paste.

The voiding for solder paste C (green) is highest within each profile. The voiding for solder paste A (blue) is lowest within each profile. The reflow profiles have some effect on voiding for each solder paste but there is a lot of overlap in the range of voiding.

Voiding Performance Ranked for Each Combination

Voiding performance ranked for the combinations of solder paste and 1st reflow profile are shown below (Figure 11).




Excluded Rows 400

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

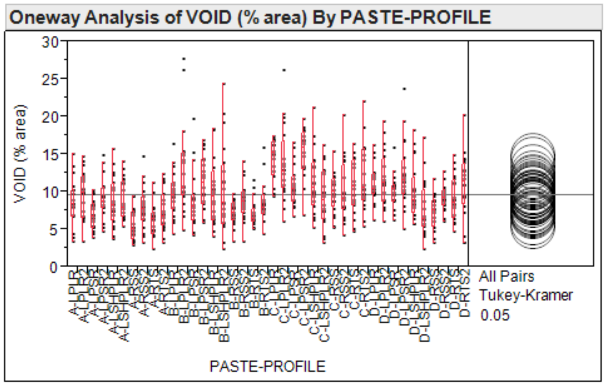
Level		Mean
C-LPLR	A	14.5
C-LSHPLR	B	11.2
D-LPLR	B	10.9
C-LPSR	B	10.8
C-RTS	B	10.7
D-LPSR	B C	10.0
D-LSHPLR	B C	9.9
C-RSS	B C	9.7
B-LSHPLR	B C	9.7
B-LPLR	B C	9.6
D-RTS	B C D	9.1
B-LPSR	B C D	8.8
A-LSHPLR	B C D E	8.6
A-LPLR	B C D E	8.4
D-RSS	C D E	7.3
B-RSS	C D E	7.2
B-RTS	C D E	7.0
A-LPSR	C D E	6.8
A-RTS	D E	6.0
A-RSS	E	5.5

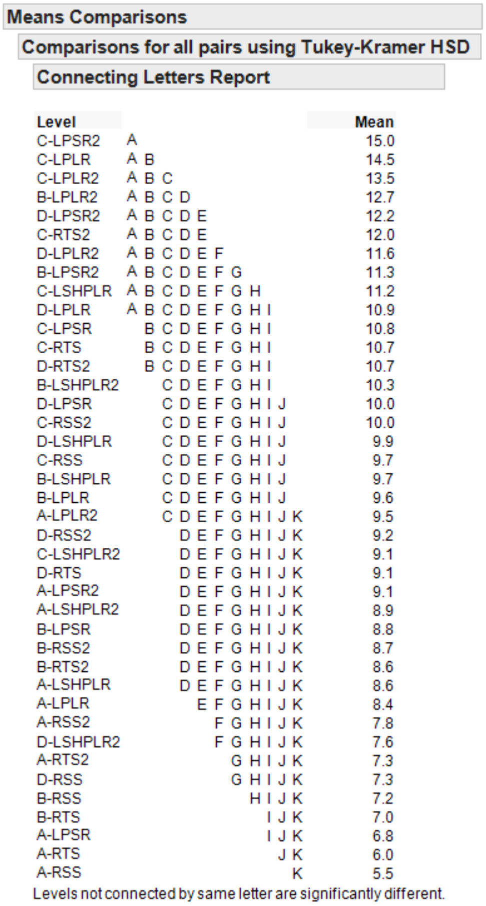
Levels not connected by same letter are significantly different.

Figure 11. Voiding for the Combinations of Solder Paste and 1st Reflow Profile.

There are 20 combinations of solder pastes, and the 1st reflow profiles. Solder paste C with the LPLR profile gave the highest overall voiding which is significantly higher than all the other combinations. Solder paste A with the RSS and RTS profiles gave statistically lower voiding than more than half of the combinations.

Voiding ranked for every solder paste – reflow profile combination including the 1st and 2nd reflows is shown below (Figure 12).




Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Connecting Letters Report

Level		Mean
C-LPSR2	A	15.0
C-LPLR	A B	14.5
C-LPLR2	A B C	13.5
B-LPLR2	A B C D	12.7
D-LPSR2	A B C D E	12.2
C-RTS2	A B C D E	12.0
D-LPLR2	A B C D E F	11.6
B-LPSR2	A B C D E F G	11.3
C-LSHPLR	A B C D E F G H	11.2
D-LPLR	A B C D E F G H I	10.9
C-LPSR	B C D E F G H I	10.8
C-RTS	B C D E F G H I	10.7
D-RTS2	B C D E F G H I	10.7
B-LSHPLR2	C D E F G H I	10.3
D-LPSR	C D E F G H I J	10.0
C-RSS2	C D E F G H I J	10.0
D-LSHPLR	C D E F G H I J	9.9
C-RSS	C D E F G H I J	9.7
B-LSHPLR	C D E F G H I J	9.7
B-LPLR	C D E F G H I J	9.6
A-LPLR2	C D E F G H I J K	9.5
D-RSS2	D E F G H I J K	9.2
C-LSHPLR2	D E F G H I J K	9.1
D-RTS	D E F G H I J K	9.1
A-LPSR2	D E F G H I J K	9.1
A-LSHPLR2	D E F G H I J K	8.9
B-LPSR	D E F G H I J K	8.8
B-RSS2	D E F G H I J K	8.7
B-RTS2	D E F G H I J K	8.6
A-LSHPLR	D E F G H I J K	8.6
A-LPLR	E F G H I J K	8.4
A-RSS2	F G H I J K	7.8
D-LSHPLR2	F G H I J K	7.6
A-RTS2	G H I J K	7.3
D-RSS	G H I J K	7.3
B-RSS	H I J K	7.2
B-RTS	I J K	7.0
A-LPSR	I J K	6.8
A-RTS	J K	6.0
A-RSS	K	5.5

Levels not connected by same letter are significantly different.

Figure 12. Voiding for Every Solder Paste – Reflow Profile Combination.

There are 40 total combinations of solder pastes and 1st & 2nd reflow profiles. The highest voiding was observed with solder paste C with 5 appearances in the highest 10 voiding means. The LP (Low Peak) profiles also showed higher voiding than the other profiles with 8 results in the highest 10 voiding means.

The lowest voiding was observed with solder paste A, with 6 appearances in the lowest 10 voiding means. The RSS and RTS profiles also gave lower voiding than the other profiles with 7 results in the lowest 10.

The 2nd reflows tended to increase voiding for most of the solder paste and reflow profile combinations. There were 7

- 2nd reflows in the highest 10 voiding means. There are some exceptions to this with 3 – 2nd reflow values appearing in the lowest 10 voiding means.

For 37 of the 40 combinations of solder paste and reflow profile, the 2nd reflow increased voiding (Table 4). Discounting the 3 - 2nd reflows which decreased voiding, the mean increase in voiding was 1.7% area.

Table 4: Voiding Comparison from the 1st to the 2nd Reflow Profile for Each Combination.

Paste – Profile 1	Mean Void Area (%)		Paste – Profile 2	Mean Void Area (%)
A-LPLR	8.4		A-LPLR2	9.5
A-LPSR	6.8		A-LPSR2	9.1
A-LSHPLR	8.6		A-LSHPLR2	8.9
A-RSS	5.5		A-RSS2	7.8
A-RTS	6.0		A-RTS2	7.3
B-LPLR	9.6		B-LPLR2	12.7
B-LPSR	8.8		B-LPSR2	11.3
B-LSHPLR	9.7		B-LSHPLR2	10.3
B-RSS	7.2		B-RSS2	8.7
B-RTS	7.0		B-RTS2	8.6
C-LPLR	14.5		C-LPLR2	13.5
C-LPSR	10.8		C-LPSR2	15.0
C-LSHPLR	11.2		C-LSHPLR2	9.1
C-RSS	9.7		C-RSS2	10.0
C-RTS	10.7		C-RTS2	12.0
D-LPLR	10.9		D-LPLR2	11.6
D-LPSR	10.0		D-LPSR2	12.2
D-LSHPLR	9.9		D-LSHPLR2	7.6
D-RSS	7.3		D-RSS2	9.2
D-RTS	9.1		D-RTS2	10.7

The largest increases in voiding due to 2nd reflow came with solder paste C and the LPSR profile, solder paste B and the LPLR profile, and solder paste B with the LPSR profile. The low peak temperature profiles tend to produce higher voiding which has the potential to increase with 2nd reflow.

Voiding was measured using 2D X-ray, and the increase in voiding due to 2nd reflow indicates an increase in 2D area of the voids. It is unlikely that the voids increased in volume during 2nd reflow but instead changed shape in a way that increased the 2D area.

Only 3 of the 40 solder paste and reflow profile combinations showed a decrease in voiding from the 1st to the 2nd reflow profile. The decreases in voiding are shown below (Table 5).

Table 5: Decrease in Voiding from the 1st to the 2nd Reflow Profile.

Solder Paste	Reflow Profile	Decrease in Voiding Mean (% Area)
C	LPLR	-1.0
C	LSHPLR	-2.1
D	LSHPLR	-2.3

Two of these combinations used the LSHPLR (long soak – high peak – long reflow) profiles. The other combination used the LPLR (low peak – long reflow) profile. The long reflow time is the common factor with these profiles, which gives more time for voids to escape from the solder joints.

CONCLUSIONS

Voiding potential of solder pastes can be affected by reflow profile. Here is a summary of the voiding results from this work.

- The solder pastes tested had a significant effect on voiding for the range of profiles tested. Solder paste C gave the overall highest voiding and solder paste A gave the overall lowest voiding.
- The reflow profiles showed different voiding behavior over the range of the solder pastes tested. The LPLR (low peak – long reflow) reflow profile gave higher overall voiding than most of the profiles tested. The RSS (ramp-soak-spike) reflow profile gave lower overall voiding than most of the profiles tested.
- Reflowing the test PCBAs a 2nd time increased 2D void area % for most of the solder paste – reflow profile combinations. This is an important result as double sided SMT assembly is very common.
- Solder paste C with the LPLR (low peak – long reflow) profile gave the highest overall voiding. Solder paste A with the RSS (ramp-soak-spike) profile gave lower overall voiding than most of the combinations. For many combinations of solder paste and reflow profile, the voiding levels were not significantly different.

Modifications to the reflow profile may affect voiding behavior, but the changes in voiding are not always statistically significant. In real world manufacturing, the goal is to reduce voiding below an established maximum limit. Reflow profile changes are often used as a first step to modify voiding behavior. In some cases, these modifications may reduce voiding below an established maximum limit. It is the hope of the author that this work is helpful for the reader to “Fill the Void.”.

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