

FIGURE 1: Final wetting angle.

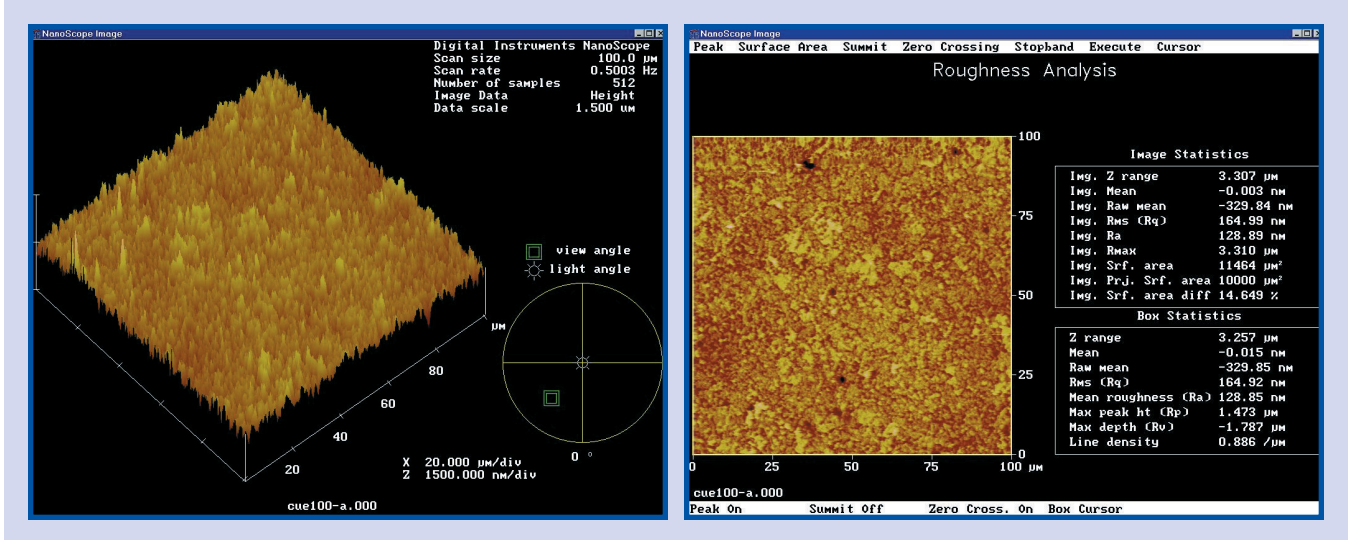


FIGURE 2: Wetting index data.

Table 1. Phase 2 DoE			
Run No.	Qty. of Samples	Var. 1 – Pot Temp.	Var. 2 – Contact Time
1	3	275°C	3 sec.
2	3	275°C	7.5 sec.
3	3	255°C	3 sec.
4	3	255°C	7.5 sec.
5	3	265°C	3 sec.
6	3	275°C	7.5 sec.

Table 2. Phase 3 DoE				
Run No.	Qty. of Samples	Var. 1 – Pot Temp.	Var. 2 – Contact Time	Var. 3 – Flux Qty
1	3	255°C	3 sec.	High
2	3	265°C	3 sec.	High
3	3	275°C	3 sec.	High
4	3	255°C	7.5 sec.	High
5	3	265°C	7.5 sec.	High
6	3	275°C	7.5 sec.	High
7	3	255°C	3 sec.	Low
8	3	265°C	3 sec.	Low
9	3	275°C	3 sec.	Low
10	3	255°C	7.5 sec.	Low
11	3	265°C	7.5 sec.	Low
12	3	275°C	7.5 sec.	Low

Table 3. Phase 4 DoE				
Run No.	Qty. of Samples	Var. 1 – Pot Temp.	Var. 2 – Contact Time	Var. 3 – Flux Qty
1	3	255°C	3 sec.	High
2	3	265°C	3 sec.	High
3	3	275°C	3 sec.	High
4	3	255°C	7.5 sec.	High
5	3	265°C	7.5 sec.	High
6	3	275°C	7.5 sec.	High
7	3	255°C	3 sec.	Low
8	3	265°C	3 sec.	Low
9	3	275°C	3 sec.	Low
10	3	255°C	7.5 sec.	Low
11	3	265°C	7.5 sec.	Low
12	3	275°C	7.5 sec.	Low

Heater Type	Location	Description	Comments
Lower convection	Slot 3 – bottom Slot 2 – bottom	Existing design for lower convection module	In the associated machine, Slot 1 is closest to the solder module
Top convection	Slot 2 – top	Unique convection design unit for upper location in a wave solder	Not interchangeable with lower unit
IR	Slot 1 – bottom Slot 1 – top		The common machine configuration is for an IR heater to be over a convection unit in Slot 1

	Profile #1	Profile #2	Profile #xxx
Conveyor fpm			
P.H. #2 - top			
P.H. #2 - bottom			
P.H. #1 - top			
P.H. #1 - bottom			
TV #1, T/C #1			
TV #2, T/C #1			
TV #3, T/C #1			
TV #4, T/C #1			
TV #5, T/C #1			

Step	Qty.	Var. 1 – Conveyor	Var. 2 – Preheat	Var. 3 – Pot Temp.
1	2	1.75 fpm	130°C	265°C
2	2	1.75 fpm	130°C	250°C
3	2	1.75 fpm	90°C	265°C
4	2	1.75 fpm	90°C	250°C
5	2	4.5 fpm	130°C	265°C
6	2	4.5 fpm	130°C	250°C
7	2	4.5 fpm	90°C	265°C
8	2	4.5 fpm	90°C	250°C

S.P. Bottom	S.P. Top	Actual – Bottom	Actual – Top
200	100	201	128
200	120	200	120
200	140	200	138
200	160	200	161
200	180	200	180
200	200	200	200
200	220	200	217
200	240	201	238
200	260	200	260
200	280	199	281
200	300	201	303
200	320	200	320
500	340	223	340
480	400	502	400
460	400	480	399
300	400	459	401
300	100	307	151
300	120	Skip	Skip
300	140	301	164
300	160	300	175
300	180	300	188
300	200	300	200

Temperatures in °C.

S.P. Bottom	S.P. Top	Actual – Bottom	Actual – Top
120	60	119	
120	80	120	
120	100	120	
120	120	120	
120	140	120	
120	160	120	
120	180	121	
120	200	124	
120	220	Not a valid setting	Not a valid setting
100	200	127	200
120	200	127	201
140	200	140	200
160	200	160	200
180	200	179	201
200	200	201	199

Temperatures in °C.

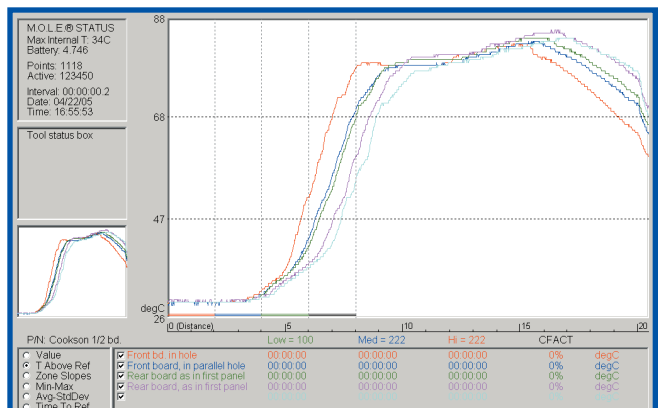


FIGURE 3: Representative profile of a top convection preheater.

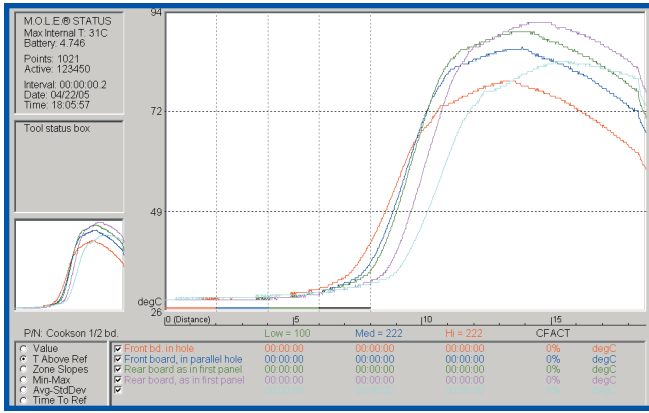


FIGURE 4: Representative profile of a top IR preheater.

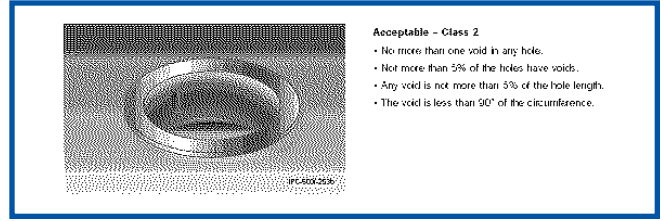


FIGURE 5: Existing standard for hole voids.

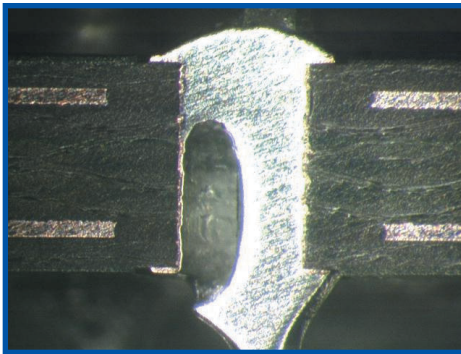


FIGURE 6: Microsection view of a void found during the study.

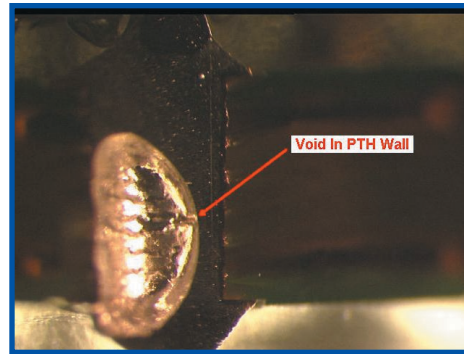


FIGURE 7: Exploded view of wall imperfection causing the void shown in Figure 6.

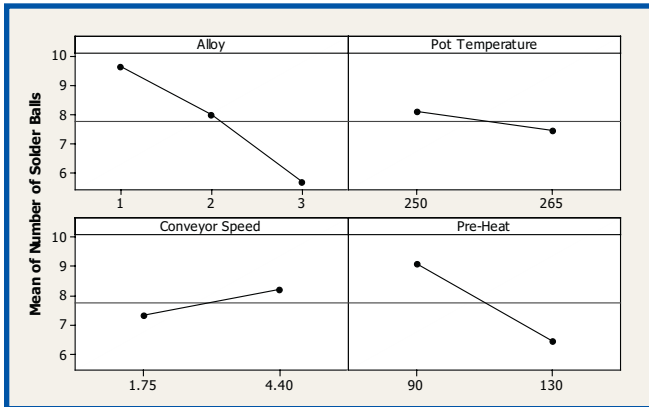


FIGURE 8: DoE main effect plots (data means) for solder balls.

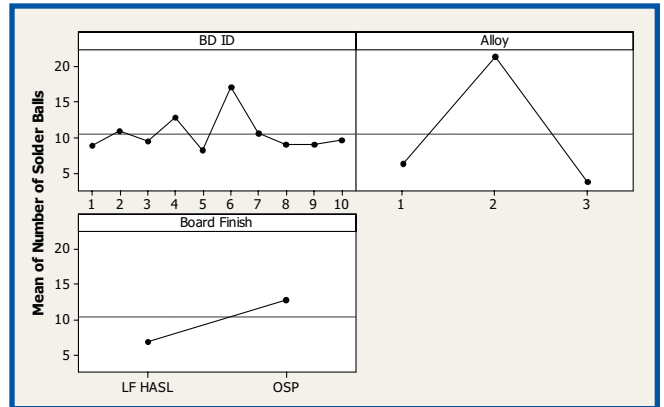


FIGURE 9: Confirmation run main effect plot.

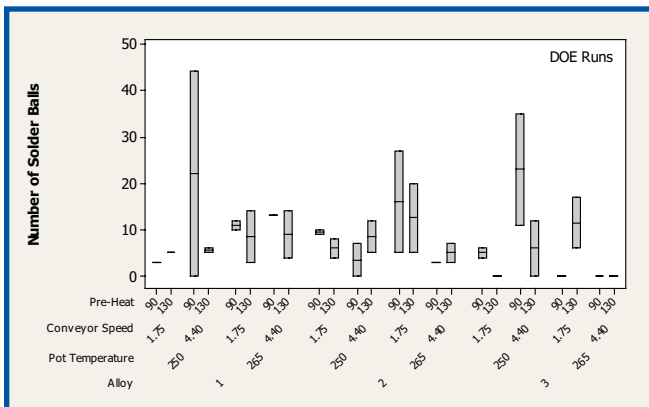


FIGURE 10: DoE box plot for solder balls vs. preheat, conveyor speed, pot temperatures and alloy.

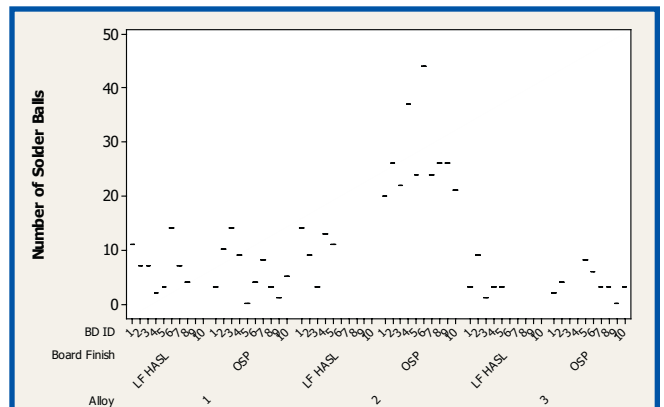


FIGURE 11: Confirmation run box plot for solder balls based on board finish.

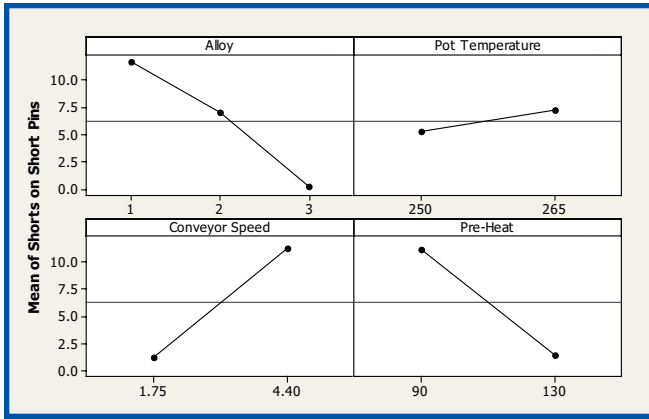


FIGURE 12: DoE main effect plots (data means) for solder shorts on DIMM.

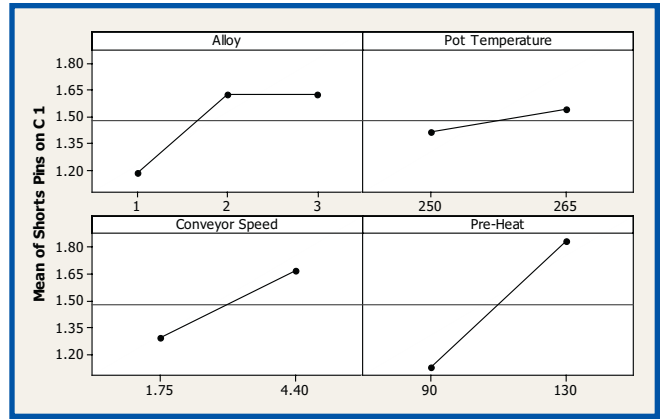


FIGURE 13: DoE box plot for solder balls.

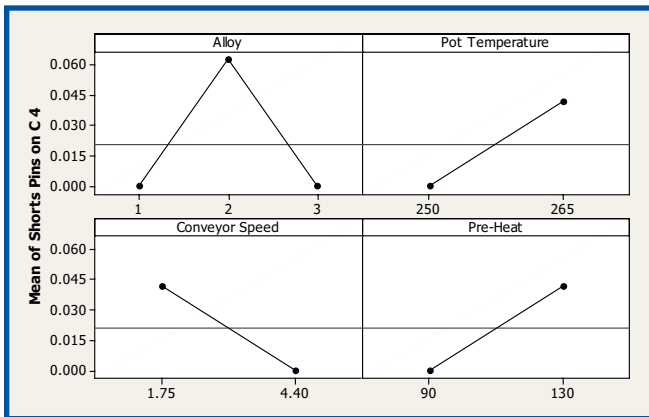


FIGURE 14: DoE main effects plot (data means) for solder shorts on C4.

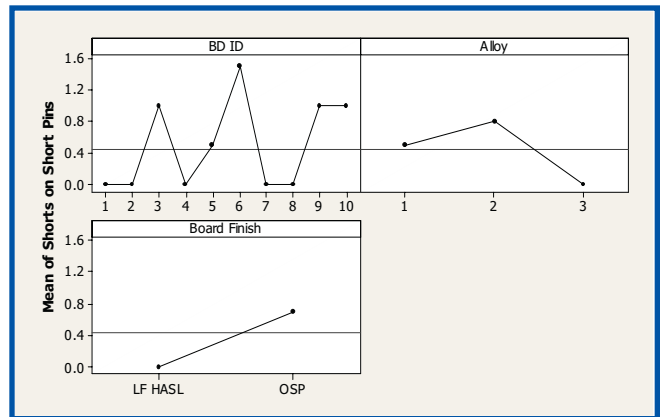


FIGURE 15: Main effects plot (data means) for solder shorts on DIMM.

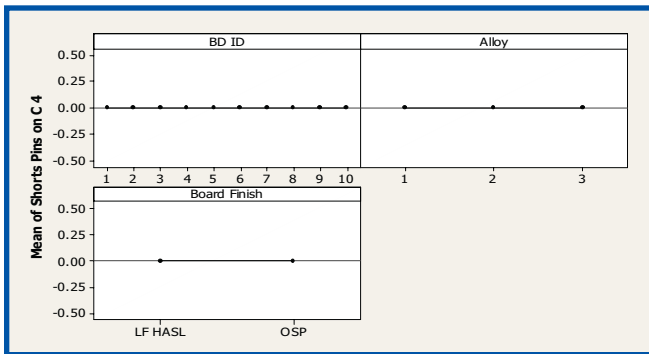


FIGURE 16: Confirmation run main effects plot (data means) for solder shorts on C4.

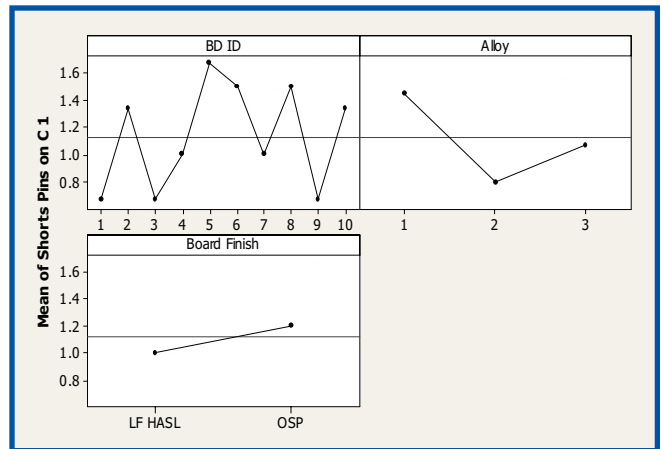


FIGURE 17: Confirmation run main effect plots for solder shorts on C1.

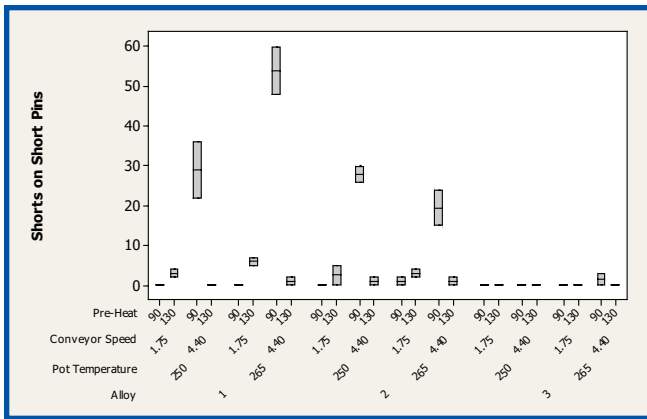


FIGURE 18: DoE box plot of solder shorts on DIMM connectors (short pins).

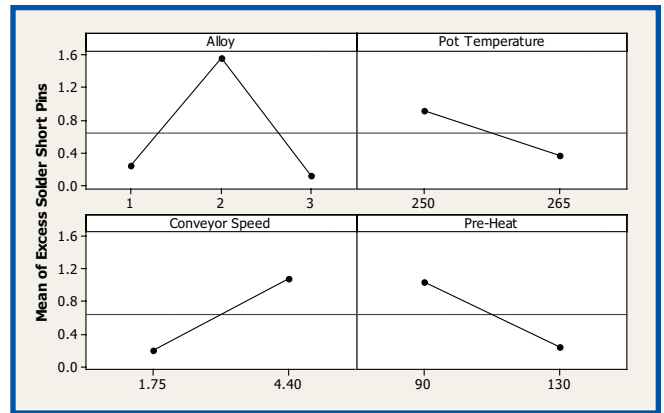


FIGURE 19: DoE main effect plots (data means) for excess solder on DIMM.

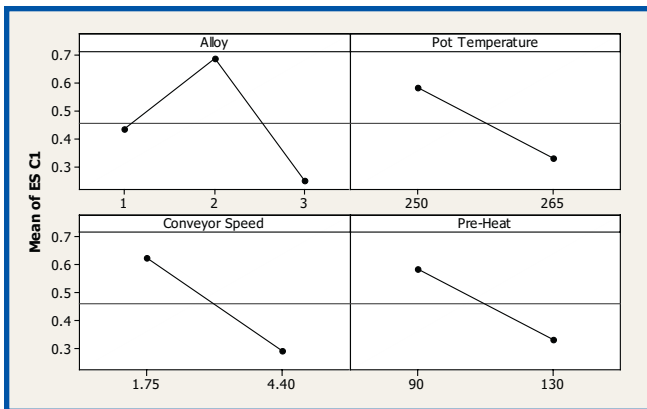


FIGURE 20: DoE main effect plots (data means) for excess solder on C1.

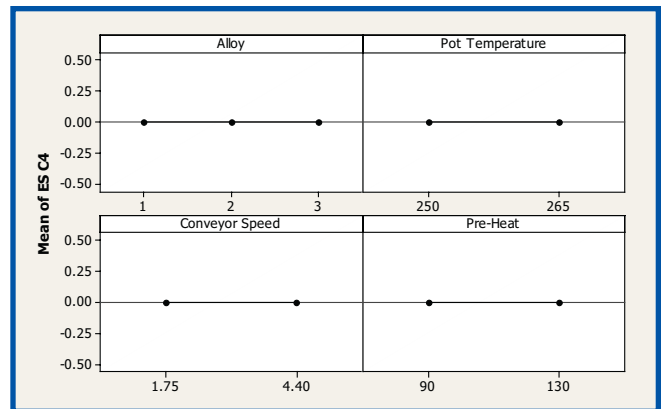


FIGURE 21: DoE main effect plots (data means) for excess solder on C4. (Note: C4 has a through-board length of 0.175".)

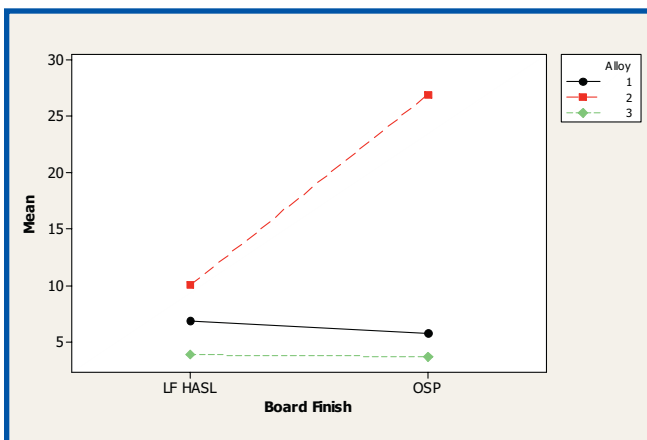


FIGURE 22: Confirmation run data for solder balls by surface finish.

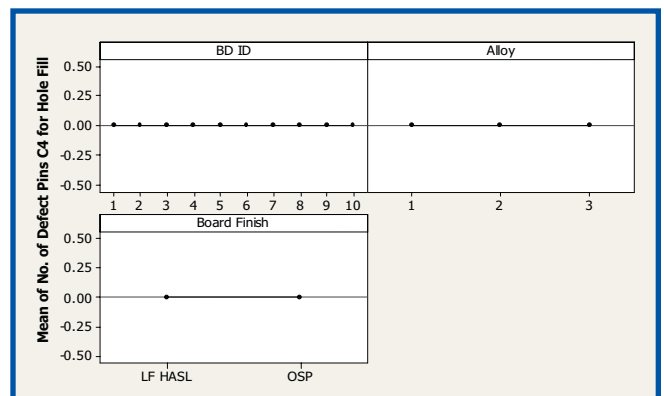


FIGURE 23: Confirmation run data for hole fill.

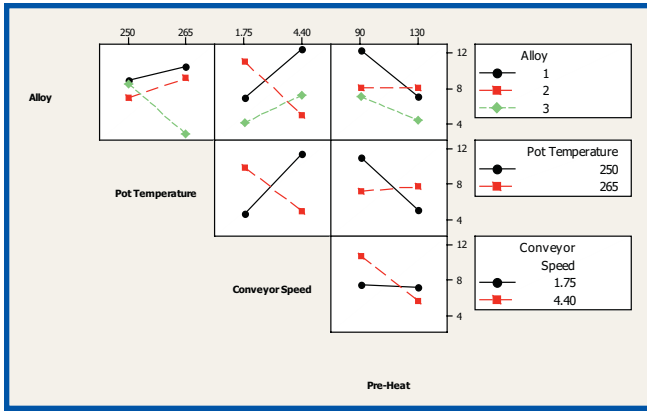


FIGURE 24: Interaction plot from DoE data (data means) for solder balls.

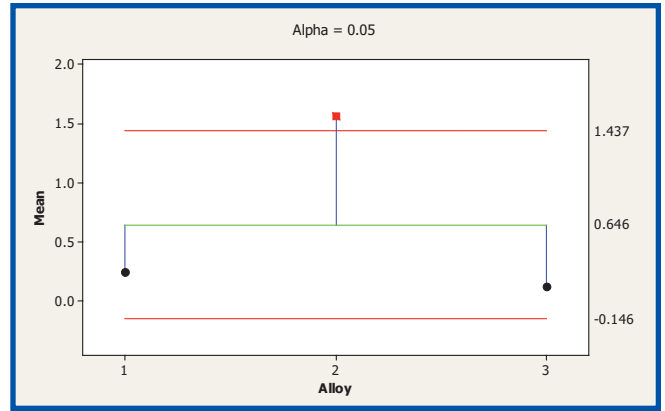


FIGURE 25: One-way ANOM for excess solder shorts on DIMM.

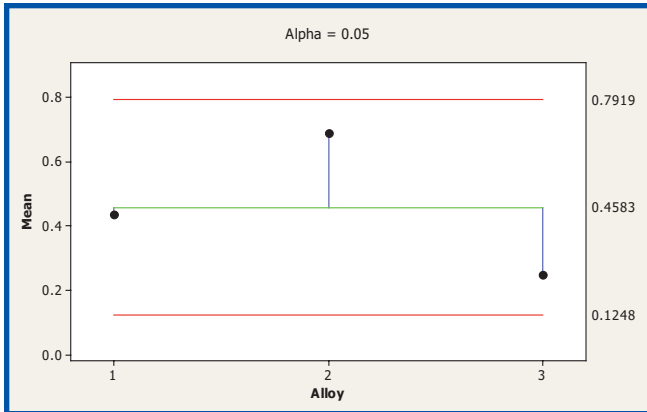


FIGURE 26: One-way ANOM for excess solder C1 by alloy.

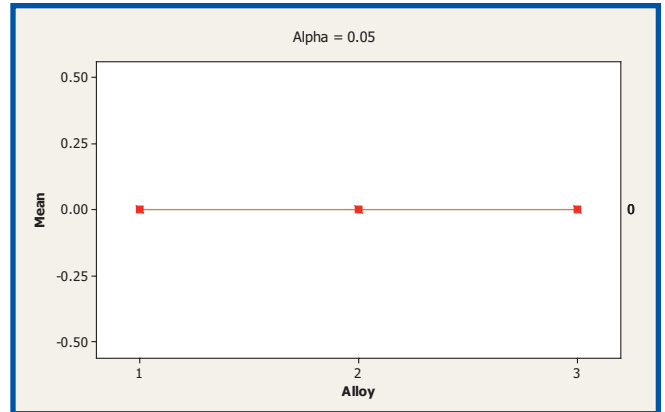


FIGURE 27: One-way ANOM for excess solder C4 by alloy.

Table 9. Confirmation Run, Non-Solder Ball Defects				
Data	Alloy 1	Alloy 2	Alloy 3	Grand Total
Sum of Shorts Pins on C3 DIMM	0	3	0	3
Sum of Shorts Pins on C2 DIMM	9	9	0	18
Sum of Shorts Pins on C1	26	12	16	54
Sum of Shorts Pins on C4	0	0	0	0
<b>Subtotal Shorts</b>	<b>35</b>	<b>24</b>	<b>16</b>	<b>75</b>
Sum of ES C3 DIMM	0	2	0	2
Sum of ES C2 DIMM	1	1	0	2
Sum of ES C1	7	10	8	25
Sum of ES C4	0	1	0	1
<b>Subtotal Shorts</b>	<b>8</b>	<b>14</b>	<b>8</b>	<b>30</b>
Sum of No. of Defect Pins C3 for Hole Fill	0	0	0	0
Sum of No. of Defect Pins C2 for Hole Fill	0	0	0	0
Sum of No. of Defect Pins C1 for Hole Fill	0	0	0	0
Sum of No. of Defect Pins C4 for Hole Fill	0	0	0	0
<b>Subtotal Shorts</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

Table 10. Confirmation Run, All Defects.				
Data	Alloy 1	Alloy 2	Alloy 3	Grand Total
Sum of No. of Solder Balls	112	320	48	480
Sum of Shorts Pins on C3	0	3	0	3
Sum of Shorts Pins on C2	9	9	0	18
Sum of Shorts Pins on C1	26	12	16	54
Sum of Shorts Pins on C4	0	0	0	0
Sum of ES C3	0	2	0	2
Sum of ES C2	1	1	0	2
Sum of ES C1	7	10	8	25
Sum of ES C4	0	1	0	1
Sum of No. of Defect Pins C3 for Hole Fill	0	1	0	1
Sum of No. of Defect Pins C2 for Hole Fill	0	0	0	0
Sum of No. of Defect Pins C1 for Hole Fill	0	0	0	0
Sum of No. of Defect Pins C4 for Hole Fill	0	0	0	0
<b>Total</b>	<b>155</b>	<b>358</b>	<b>72</b>	<b>585</b>