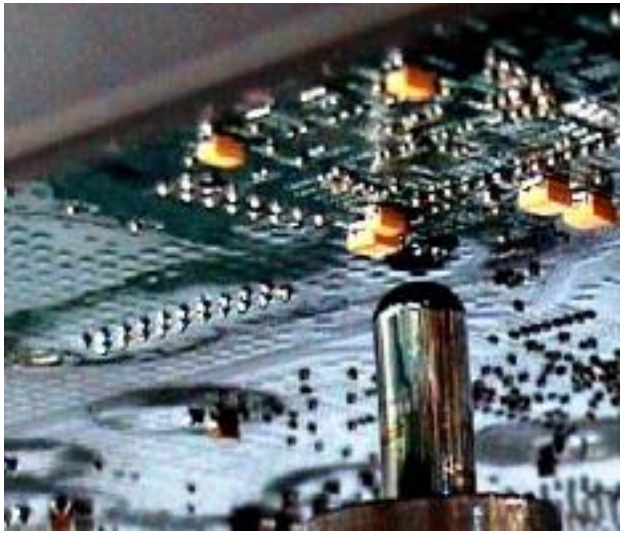
Liquid Flux Selection and Process Optimization for Selective Soldering Applications

Poster: **P13** Ballroom A

Alpha *an Alent plc Company*
Mike Murphy – ***mmurphy@alent.com***
Russell Maynard
Laxminarayana Pai
Corné Hoppenbrouwers
Ansuman Das
Anubhav Rustogi



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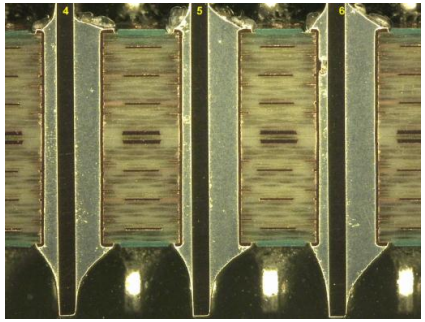
Background

- There has been a rapid increase in the use of selective soldering equipment for PCB assembly
  - Lower equipment costs
  - Smaller equipment footprint
  - Lower solder “inventory” cost (smaller pots)
  - Decrease use of through hole devices
  - Some technical challenges
    - Tighter component spacing
    - More complex board designs
    - Increased desire to control flux spread

The selective soldering process is much different that wave soldering so there are different liquid flux considerations

Study Objectives

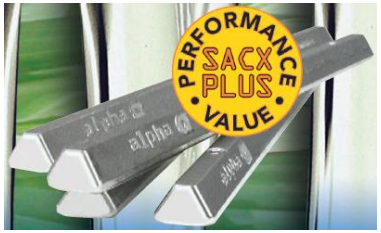
- Determine which categories of fluxes work best under several different selective soldering process parameters including:
  - Different pre-heat and solder pot temperatures
  - Different levels of flux loading
  - Different solder pot contact times
- Identify optimum performance settings for each flux category
- Identify impact of each process parameter on overall soldering performance
    - This report focuses on hole fill



Fluxes Tested

Flux #	Solvent	Rosin (Y / N)	IPC Class	Solid %	Acid #	ECM Reliability
1	Water	N	ORL0	4	31.5	Bellcore SIR
2	Water / Alcohol	Y	ORL0	4	26.3	IPC JSTD-004B
3	Alcohol	N	ORL0	2.2	17.5	Bellcore SIR
4	Alcohol	Y	ORL0	3.8	23.9	IPC JSTD-004B
5	Alcohol	Y	ORL0	3.6	22.4	IPC JSTD-004B
6	Alcohol	Y	ROL0	4	21.5	IPC JSTD-004B
7	Alcohol	Y	ROL0	6	27.0	IPC JSTD-004B
8	Alcohol	Y	ROM1	7	16.1	IPC JSTD-004B

Alloy Used – ALPHA SACX Plus® 0807



Equipment Used

Pillarhouse Jade S-200

- Drop jet fluxer
- Top side IR pre-heat

Drop-jet fluxer with aperture size 270μm

12mm ‘fountain’ type nozzle

Test Vehicle

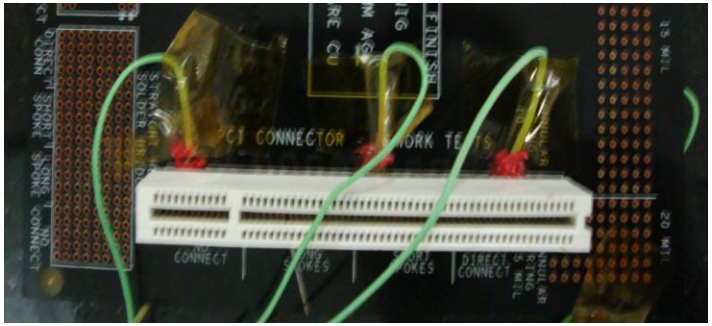
- .093” (2.4mm) thick
- 4 x 1 oz Cu signal layers
- FR-4, glossy solder mask
- Entek HT OSP pad finish

- PCI Connector with 120 square .014’ x .009” leads in .040” PTH’s

- The test vehicle was preconditioned with two lead-free reflow profiles
  - Selective soldering is frequently used following dual-sided SMT processes

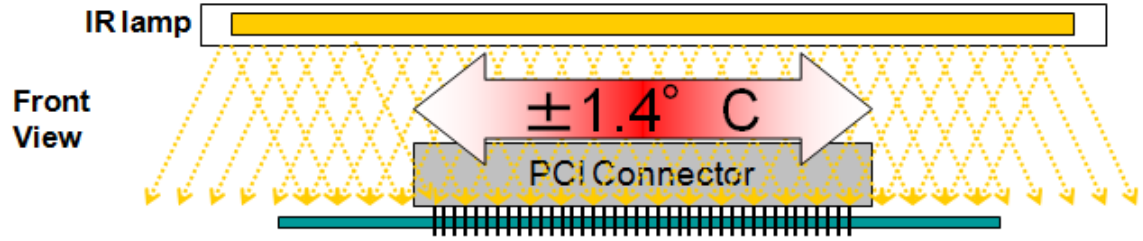
Set Up

Flux solids loading determined using Wet Gravimetric method



Thermocouples attached at various locations to measure thermal profile

Proper board orientation established for most uniform heat distribution

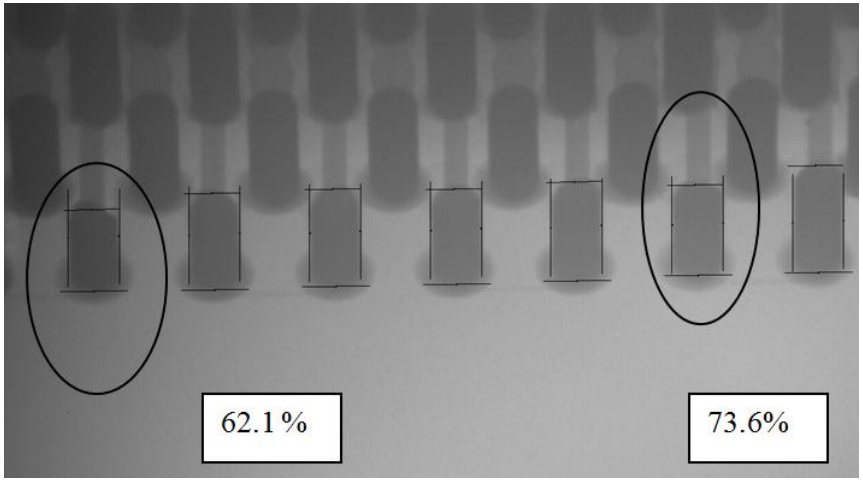


Variables

Parameters	Low	Centre	High
Amount of flux solids(ug/cm^2)	190	250	310
Topside Preheat Temperature(^{0}C)	70	100	130
Solder Pot Temperature (^{0}C)	280	295	310
Contact time (sec.)	2	3.5	5

Hole-Fill Measurement

- X-ray equipment calculates hole fill levels using the grey-scale difference between the filled and unfilled area of the barrel

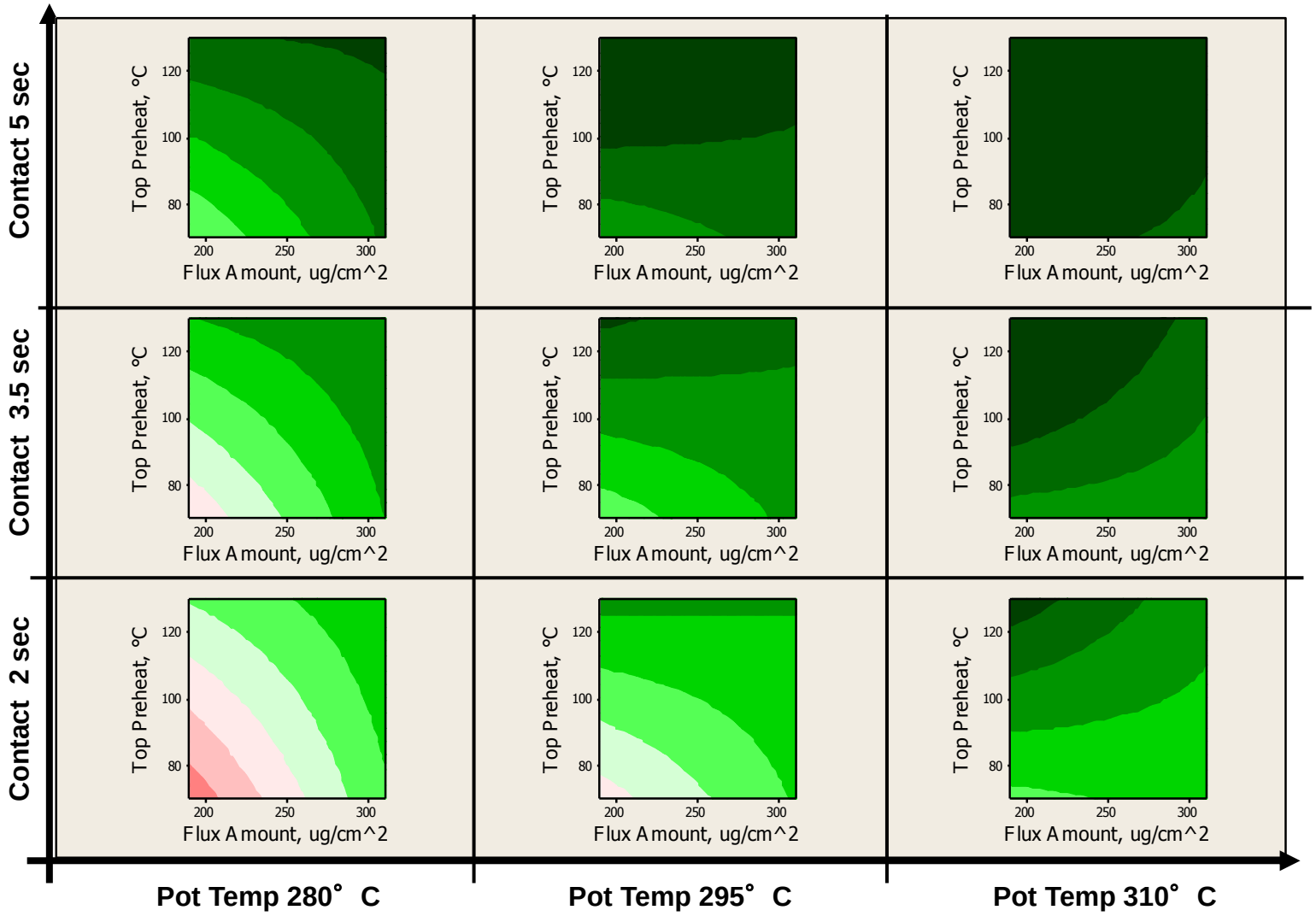


Results and Observations

- With the focus on Hole-Fill:
  - Contour Plots were developed and used to find the ‘Operating Window’ for each flux tested
  - Minitab® Response Optimiser was used to find the optimum settings within each fluxes ‘Operating Window’

Example: **Flux #5**

% of Holes Filled >75% Volume on a 2.4mm board



Flux Guidelines for **1.6mm** Boards

Settings required to achieve >75% fill on 100% of holes

Solder Contact Time, seconds	280 °C Flux #	280 °C Process Guidelines	295 °C Flux #	295 °C Process Guidelines	310 °C Flux #	310 °C Process Guidelines
5	1	FS310, PH70	2	FS190-250, PH70-130	1	FS190, PH70-130
	3	FS190-310, PH70-130	3	FS190-310, PH70-130	2	FS190-310, PH70-130
	4	FS310, PH70	4	FS190-310, PH70-130	3	FS190-310, PH70-130
	5	FS190-310, PH70-130	5	FS190-310, PH70-130	4	FS190-310, PH70-130
	7	FS310, PH70-130	6	FS310, PH70	5	FS190-310, PH70-130
			7	FS310, PH70-130	6	FS190-310, PH70-130
			8	FS190, PH130, or; FS310, PH70	7	FS190-310, PH70-130
					8	FS190-310, PH70-130
3.5	1	FS310, PH70	1	FS310, PH70	1	FS190, PH130
	3	FS310, PH70-130	3	FS190-310, PH70-130	2	FS190-250, PH110-130
	5	FS310, PH70-130	4	FS310, PH70-130	3	FS190-310, PH70-130
	7	FS310, PH70	5	FS190-310, PH70-130	4	FS190-310, PH70-130
			7	FS310, PH70-130	5	FS190-250, PH100-130
					6	FS190-310, PH70-130
					7	FS190-310, PH70-130
					8	FS310, PH70-100
2	1	FS310, PH70	1	FS310, PH70	3	FS190-310, PH70-130
	3	FS310, PH70-130	3	FS310, PH70-130	4	FS190, PH130, or; FS310, PH70
	5	FS310, PH70-130	5	FS310, PH70-130	5	FS190, PH130
					6	FS190, PH70-130
					7	FS310, PH70

Solder Pot Temperature, °C

FS = Flux Solids, μg/cm2

PH = Pre-Heat, ºC

Green Numbers = Optimum Settings

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Flux Guidelines for **2.4mm** Boards

Settings required to achieve >75% fill on 100% of holes

Solder Contact Time, seconds

	280		295		310	
	Flux #	Process Guidelines	Flux #	Process Guidelines	Flux #	Process Guidelines
5	3	FS190, PH130	3	FS190-290, PH100-130	1	FS190, PH70
	5	FS310, PH130	4	FS190, PH130	3	FS190-310, PH70-130
	7	FS310, PH70	5	FS190-310, PH100-130	4	FS190-310, PH70-130
			7	FS250-310, PH70-100	5	FS190-310, PH70-130
					6	FS190-250, PH70-130
					7	FS190-310, PH70-130
3.5	N/A		3	FS190, PH130	3	FS190-310, PH70-130
			5	FS190, PH130	4	FS190-310, PH70-130
					5	FS190, PH100-130
					6	FS190-310, PH70-100
					7	FS310, PH70
2	N/A		N/A		3	FS190-250, PH130
					4	FS190-250, PH130
					5	FS190, PH130
					6	FS190, PH70

Solder Pot Temperature, °C

FS = Flux Solids, µg/cm2

PH = Pre-Heat, °C

Green Numbers = Optimum Settings

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Conclusions

- Most common fluxes, when used in a typical selective solder process, can produce acceptable IPC Class III solder joints on standard thickness (1.6mm / 0.062”) PCB’s
- Alcohol based fluxes should be used for thicker (≥2.4mm / 0.093”) PCB’s
- Alcohol fluxes with >6% solids (activator + rosin) did not produce acceptable hole fill on thicker PCB’s under any condition
- Increases in pre-heat and solder pot temperatures have a greater impact on hole fill than flux amount
- PCB design may limit process settings and restrict an assemblers ability to use optimal process conditions
- Other flux factors such as ECM reliability, pin testability and compatibility with other board level materials must be considered when selecting an appropriate liquid