Reworking POP
(Package on package components)

POP New Challenges for BGA Rework with Double-Sided Lead-Free PCB's

Presented By Paul Wood

Redefining PCB Lead-Free Rework

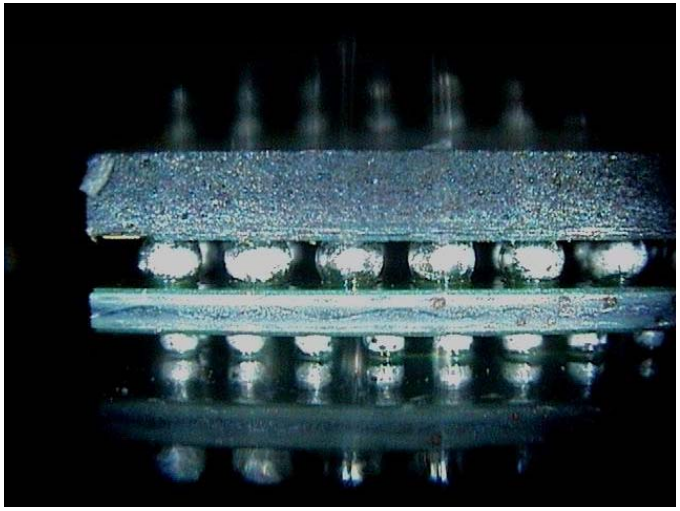
A DOVER™ COMPANY

OK INTERNATIONAL

Package on package components

- **Why use them?**

- **What is it?**



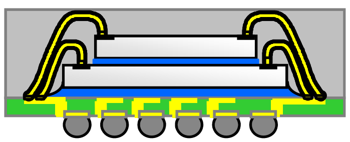
- Faster switching speeds
- Less real estate used by 50% for double stack, with much more space

Package on package components

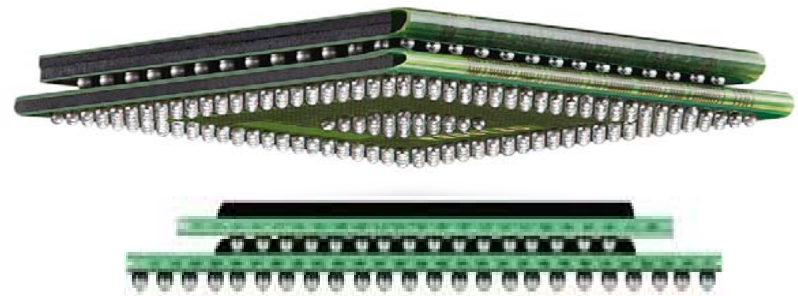
- Dram,Ddram Sram,Flash,and processor can all be mixed vertically.
- Different manufacturers' have different prices and benefits, these can now be mixed in one flexible package.
- This technology can go vertical up to 4 level external packaging.
- Each internal package can go to 5 stacks internally within .8 mm height see Intel web site. http://www.intel.com/design/flash/packtech/index.htm

Various Stacked devices

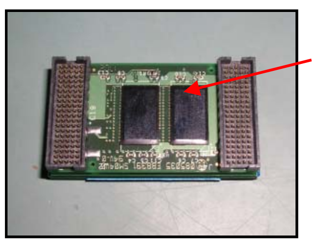
Intel® Internal
2 Stacked CSP



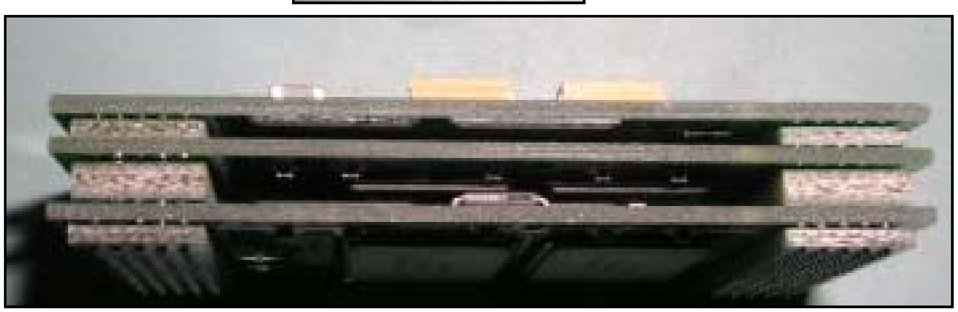
BGA Stacked



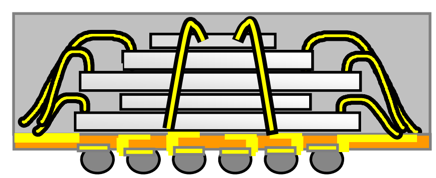
Server Memory from Viking



2×256k chips
Each side top
+ bottom ×3 level's
=12× 256 chips



1.0mm High profile 5 internal die Ram chips

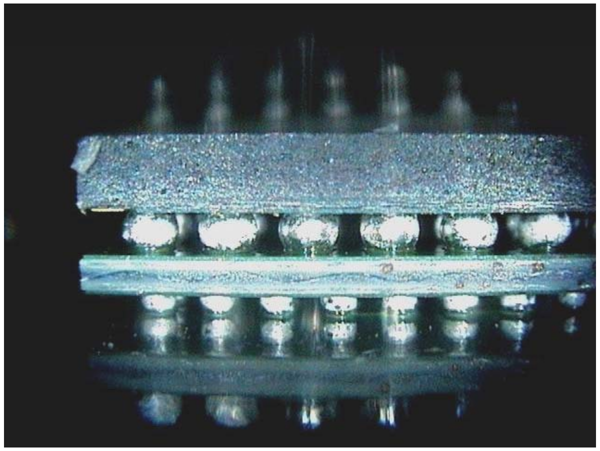


Reworking POP Packages

- Double-sided, LF PCB's present major rework challenges but now we have POP
  - Higher LF temperatures can increase likelihood of the POP top package to see higher temperatures than before, due to increased mass of array on PCB
  - In removal and replacement all solder balls melt at the same temperature.
  - These are externally mounted Components mounted vertically on top of each other.

Demo Pop Stacked devices

Amkor POP



Universal POP

A DOVER™ COMPANY

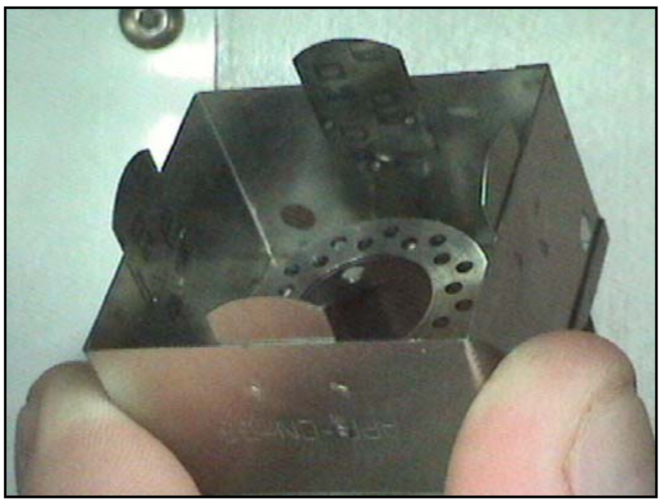
OK INTERNATIONAL

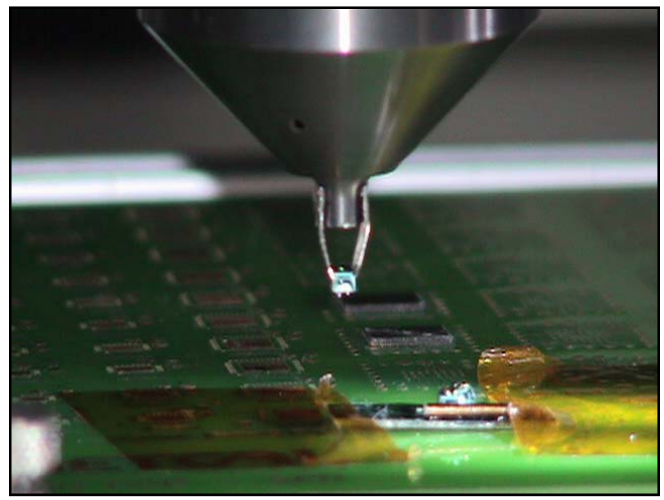
How can POP be removed

- By reworking twice as all balls melt at the same temperatures so packages will separate.
- This leaves one on pcb as vac cup removes top only.
- Glue parts together then wait for glue to be solid.
- Manually remove with hand tweezers risking damage to pcb, then no failure analysis can be carried out on faulty package.
- New design and process required.

New Tweezer Nozzle designs

- These grip parts at various locations and lift total package up from PCB.
- Not manual thermally controlled to tweezer the parts for complete or separate stack removal as a process in machine software.

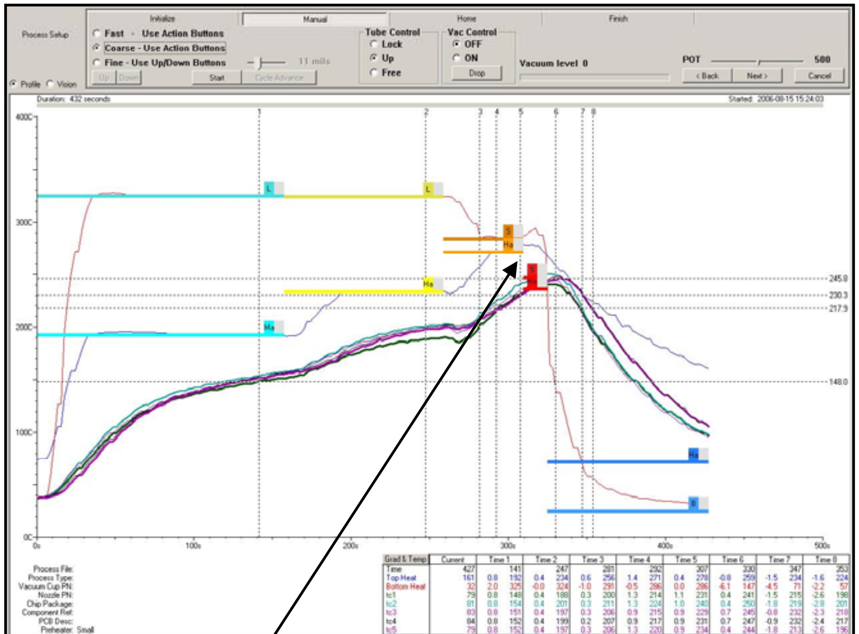


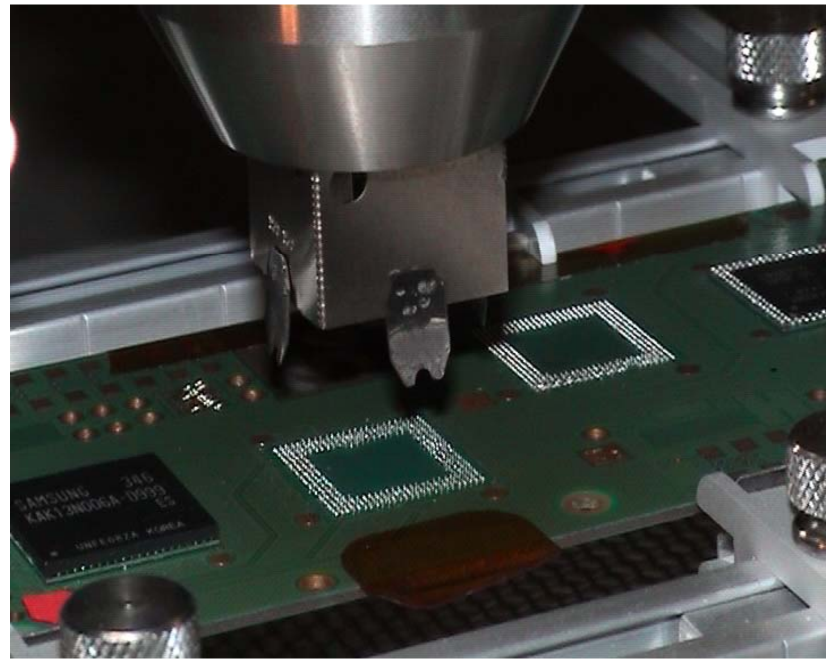


How do New Tweezer Nozzle designs work

- They bend in at 200c to grip the component by the air heating up a specially designed material that will bend in approximately 2mm each side to hold any device.
- Many devices cannot be removed or held by vac cups for many reasons.
- Grip, surface has no seal, to much suction to the PCB by solder surface tension being greater than vac seal.
- Now very common in Lead Free LGA

How do New Tweezer Nozzle design work

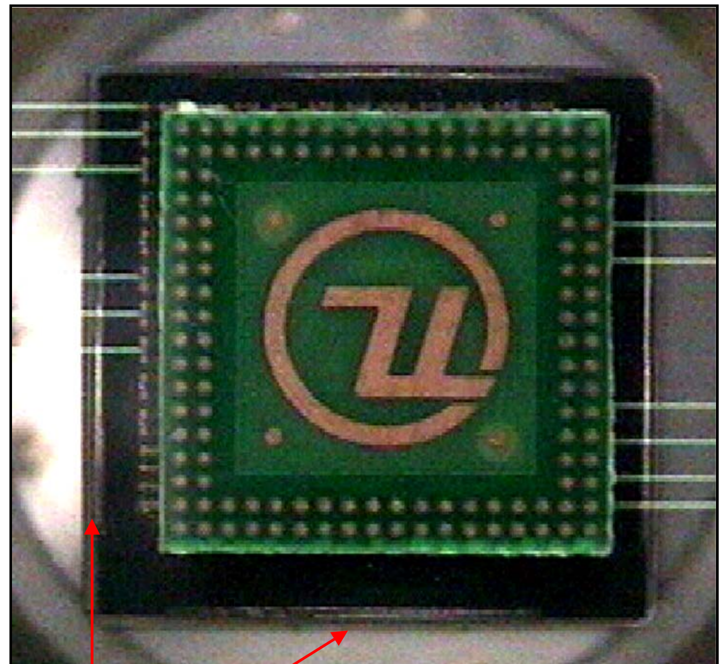




Tweezers' grip here above 200ºc nozzle temp

Remove Process for POP

- Process for remove
- Lower tweezer nozzle with no vac cup inside.
- In new software version remove tweezer process is in software to cut vac off for this process's 2.50
- Profile Package so bottom balls on PCB are @reflow and lift up in manual or remove process.
- POP stack will be completely removed both sections.

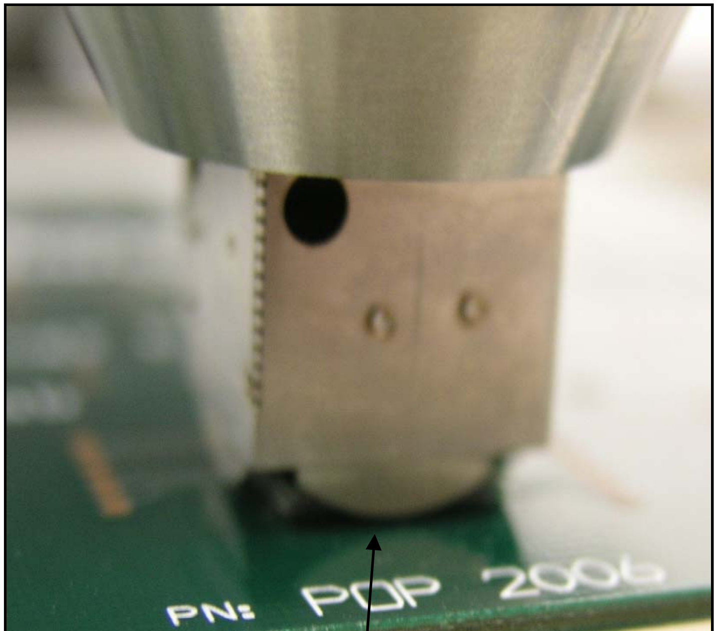


Thermal Tweezers

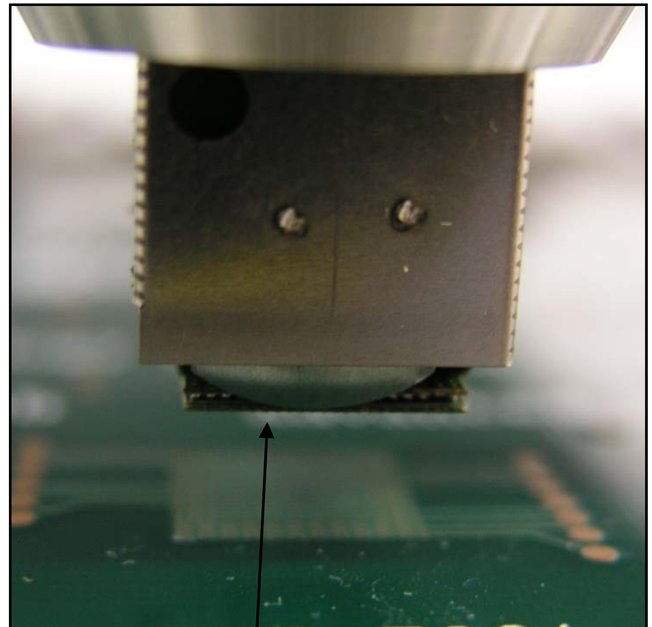
A DOVER COMPANY

OK INTERNATIONAL

Remove Process for POP



Tweezers to just be
above PCB surface



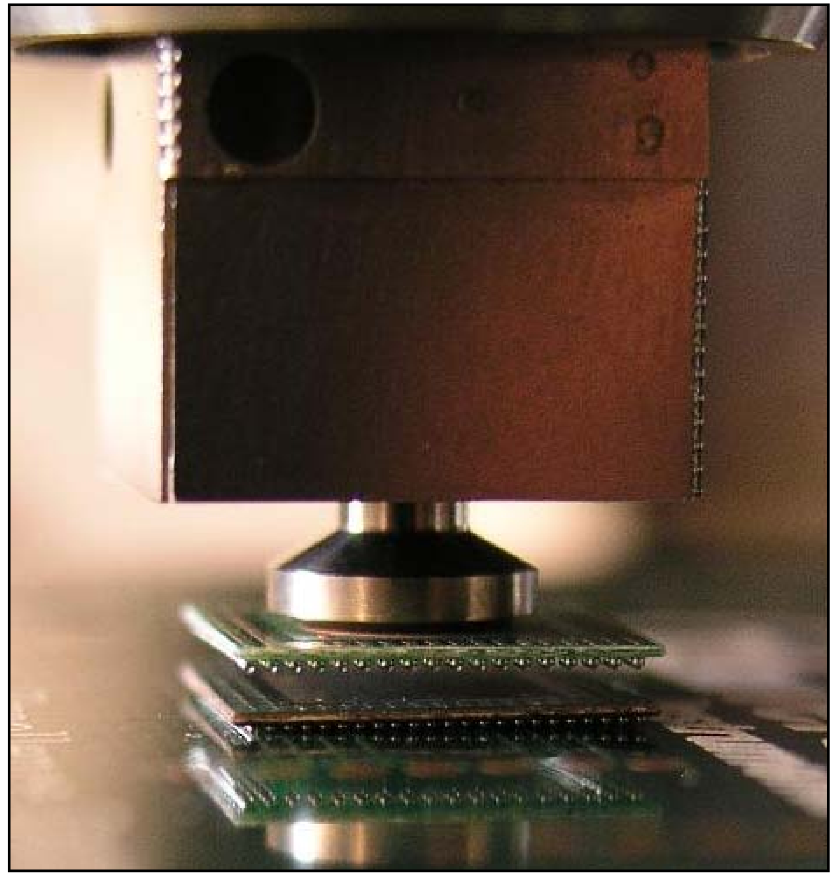
Tweezers grip and
lift up both stacks

Place Process POP

- After cleaning PCB place first POP bottom package using flux dip ,solder paste is a option see other documents for supporting this process.
- Solder ball height is 10 mil(.25mm)
- Flux dip Universal Demo Pcb using 4 mil(.1MM)DTBK .004Mil block is best but trials can be done using csp dip plates 6mil(.15mm) .
- Ideal flux Dip is half ball height
- Place first package then continue and pick and flux dip top package.
- Top package has a different ball size 16 mil (.4mm)after reflow 14mil(.35mm) so csp dip plate is ideal@6Mill(.15mm)

Place top package POP

- Use normal nozzle with vac cup for placement
- Place top package and watch puff of time does not move packages 250 setting is OK.
- Lower nozzle to within 2mm of PCB.
- Reflow to normal lead free profiles as per next slide.



OKi's ***New Process:***

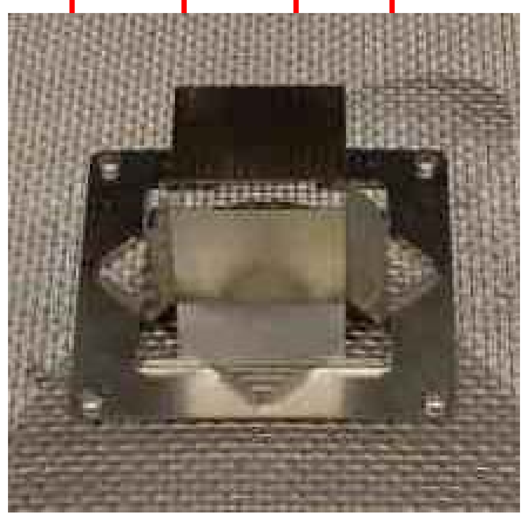
Selective Preheating on Double-Sided PCBs

Top: hot air nozzle, variable by zone

Nozzle temperature 260ºc

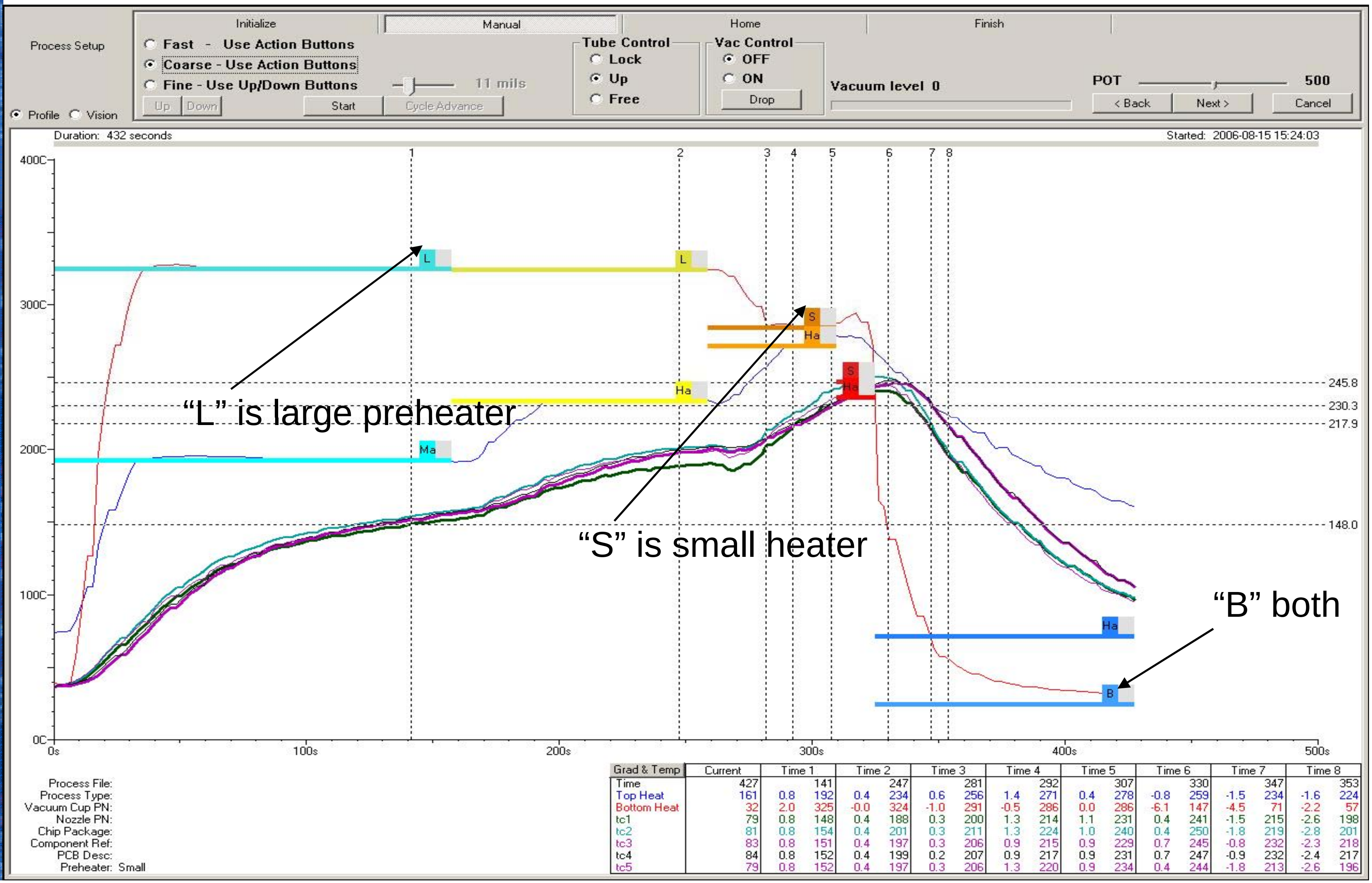
Ball temperature of 235-245°C from combined output from Pre-heater and nozzle achieve

Selective heating focuses directly under the POP component. Provides extra power for faster ramp rate On high mass POP parts



Bottom Component Temperature should be **Below Reflow 217ºc**

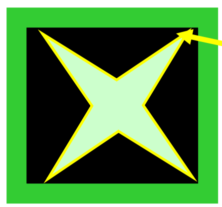
Dual Heating Software Sample Profile



Grad & Temp	Current	Time 1		Time 2		Time 3		Time 4		Time 5		Time 6		Time 7		Time 8	
Time	427		141		247		281		292		307		330		347		353
Top Heat	161	0.8	192	0.4	234	0.6	256	1.4	271	0.4	278	-0.8	259	-1.5	234	-1.6	224
Bottom Heat	32	2.0	325	-0.0	324	-1.0	291	-0.5	286	0.0	286	-6.1	147	-4.5	71	-2.2	57
tc1	79	0.8	148	0.4	188	0.3	200	1.3	214	1.1	231	0.4	241	-1.5	215	-2.6	198
tc2	81	0.8	154	0.4	201	0.3	211	1.3	224	1.0	240	0.4	250	-1.8	219	-2.8	201
tc3	83	0.8	151	0.4	197	0.3	206	0.9	215	0.9	229	0.7	245	-0.8	232	-2.3	218
tc4	84	0.8	152	0.4	199	0.2	207	0.9	217	0.9	231	0.7	247	-0.9	232	-2.4	217
tc5	79	0.8	152	0.4	197	0.3	206	1.3	220	0.9	234	0.4	244	-1.8	213	-2.6	196

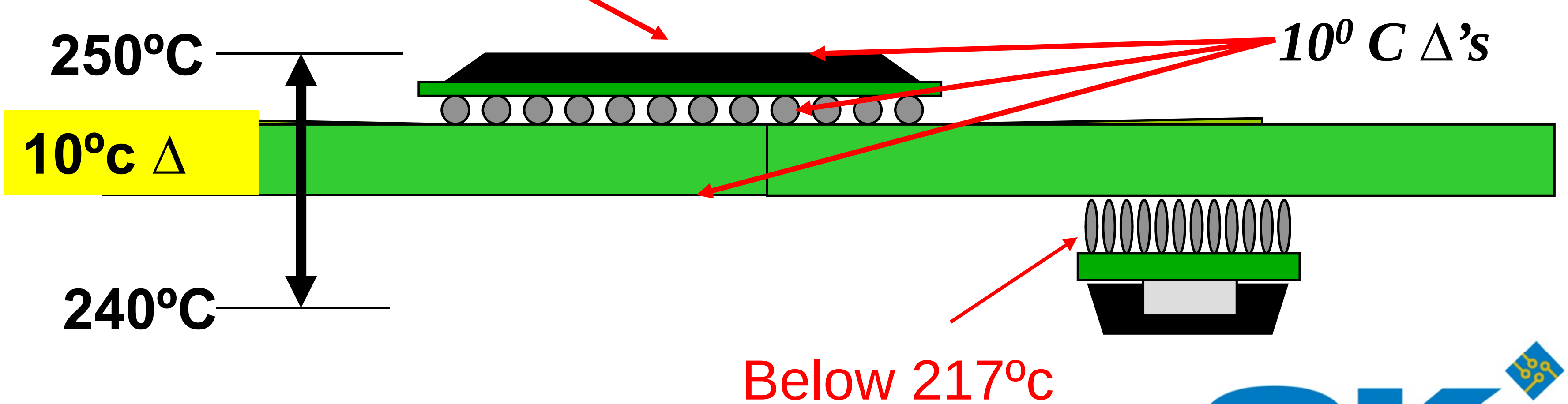
BGA LF Temperature Delta Specification

Where to Measure + locate T/C's



$\Delta\ T^0$ was 10^0 C in PB, now 5° C in LF, if possible

Maximum lid temperature 250°-260°C



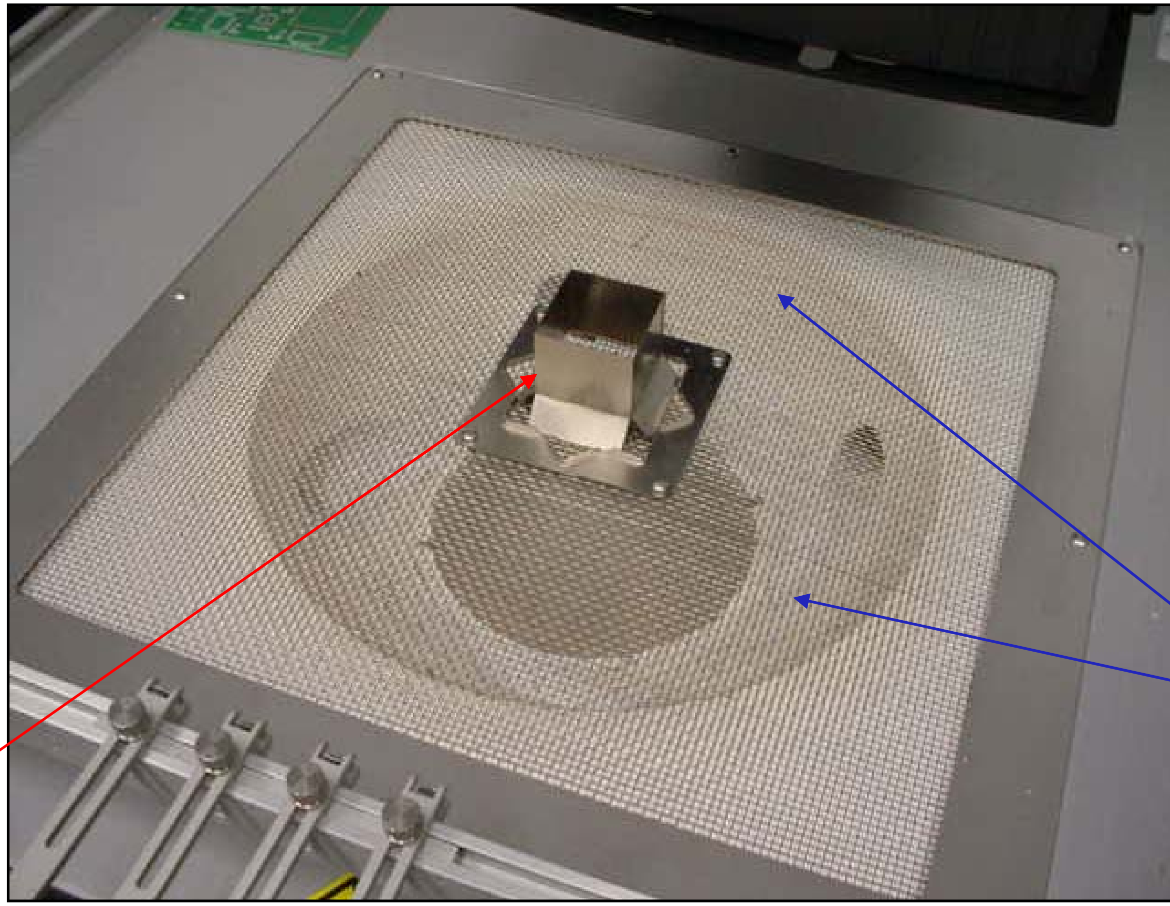
A DOVER™ COMPANY

OK INTERNATIONAL

Double-sided Lead-Free Rework

- Challenge: Reflow / Rework topside BGA to LF specifications and NOT reflow bottom-side parts
  - Difficult to impossible task but customers ask this.
- Conventional Answer: Reduce preheater tempertures and increase nozzle (topside)
  - High nozzle air temp will exceed BGA body Lid max temp specifications if preheater is not effective
  - High temperatures can create potential for warping and damaging of BGA's (IPC Max BGA body 260ºC)Most want 250ºC these days.

XL Dual Zone convection Preheater



Outer Zone 2

Inner Zone 1

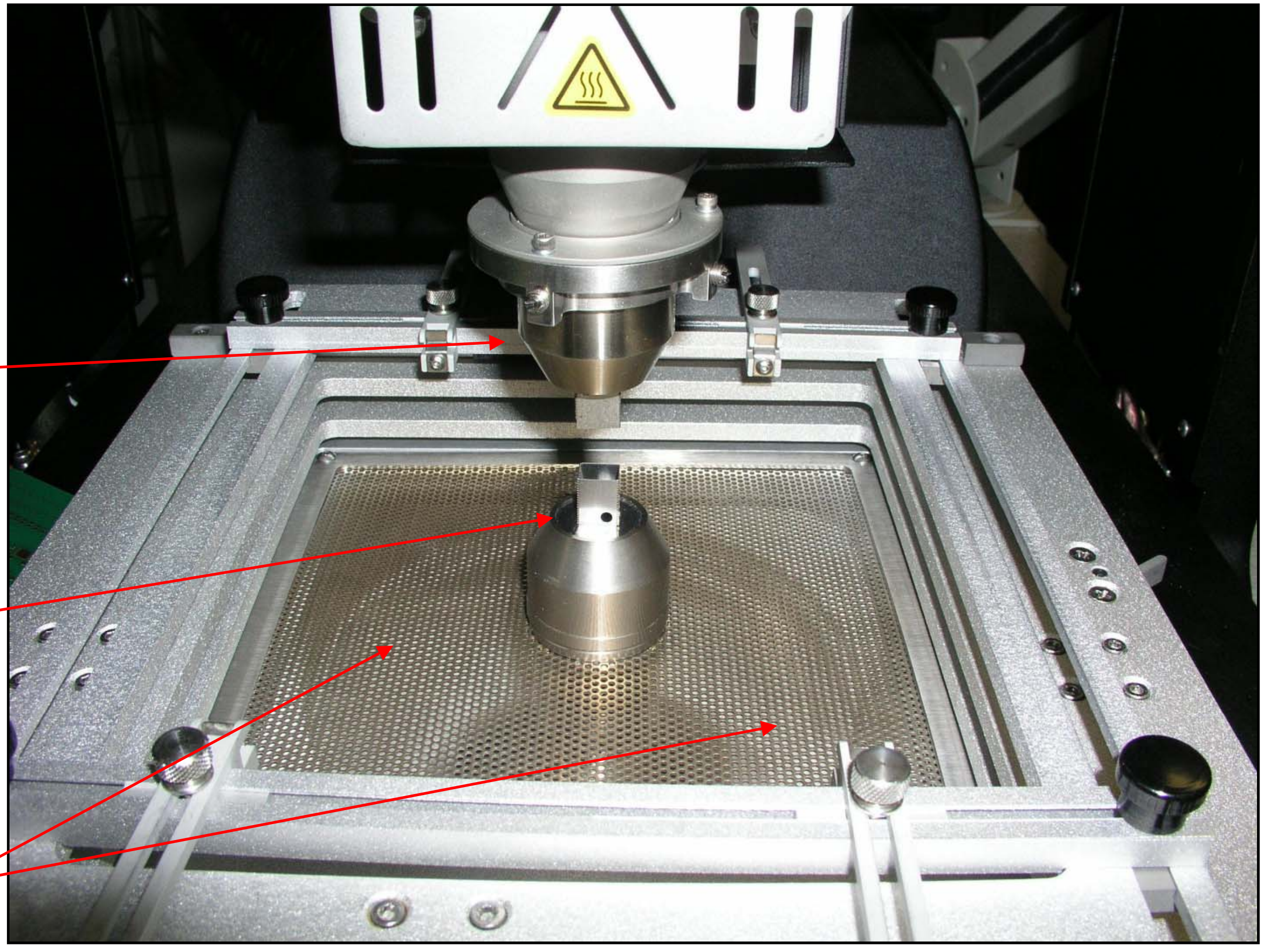
A DOVER COMPANY

OK INTERNATIONAL

APR-5000-DZ

- Smaller APR with dual zone heating.
- Can use standard nozzles from reflow top heater as center heater dual zone.
- This will locally be heating any component from below.
- This will be Particularly useful for ground pad LGA and POP components.

Preheater APR 5000 DZ Using Standard Nozzles For Dual Preheater reflow zone



Top heater 550W

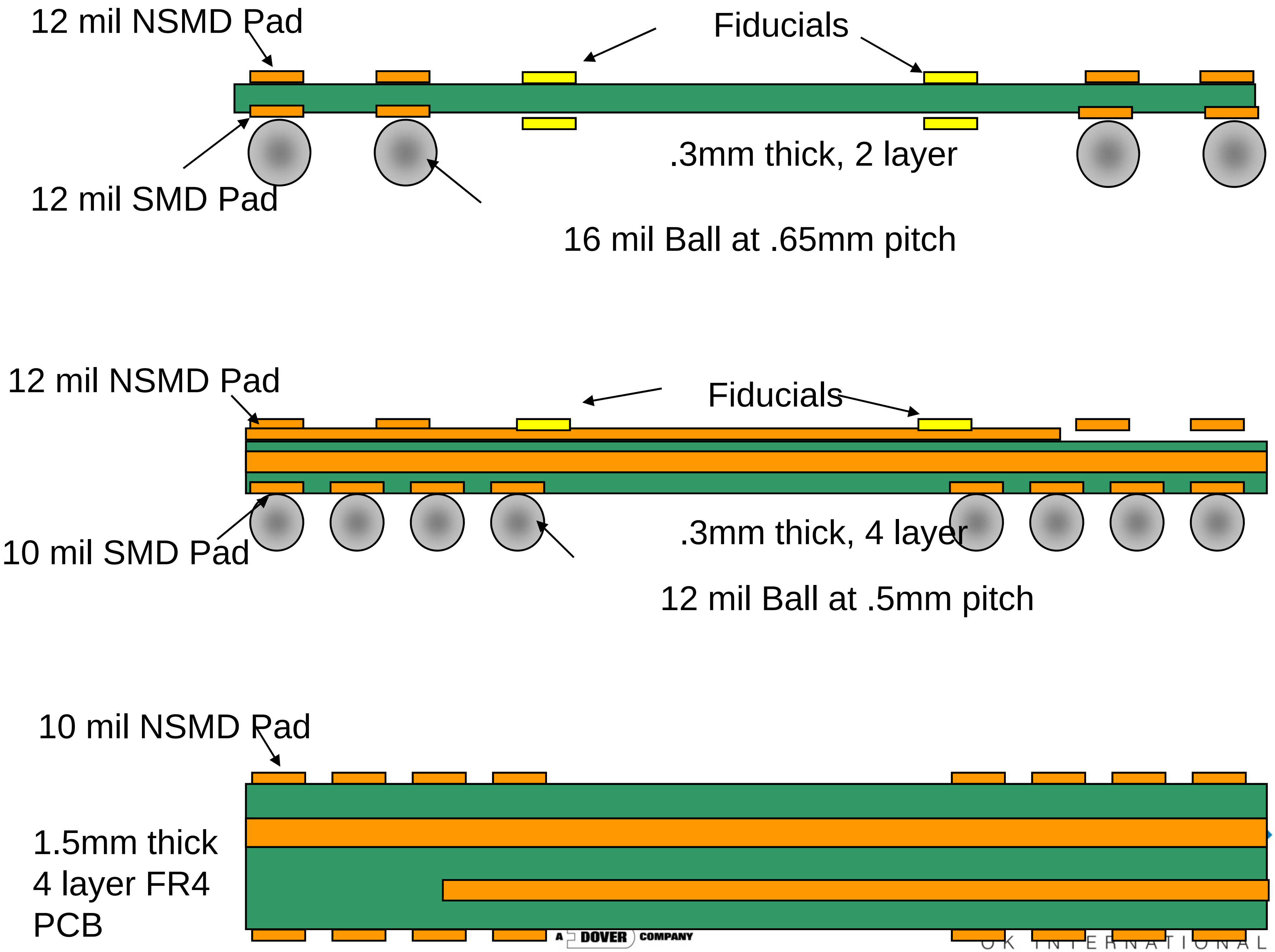
1× 900w Inner small heater

2×900w Outer heater

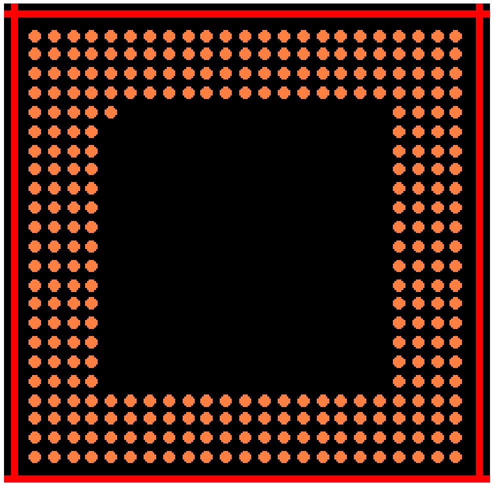
A DOVER™ COMPANY

OK INTERNATIONAL

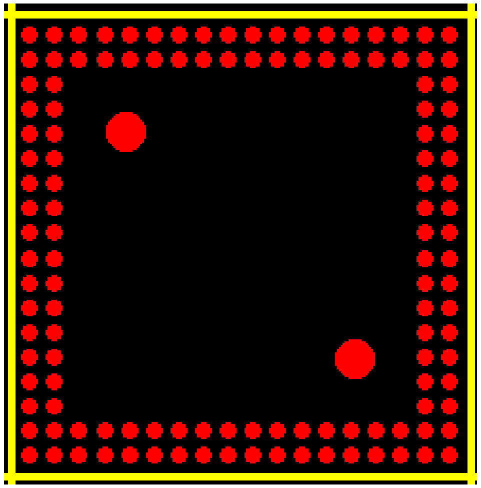
Univos (Universal) demo PCB



POP demo packages



Bottom Package
(Bottom Surface w/ Balls
Matches PCB Footprint)

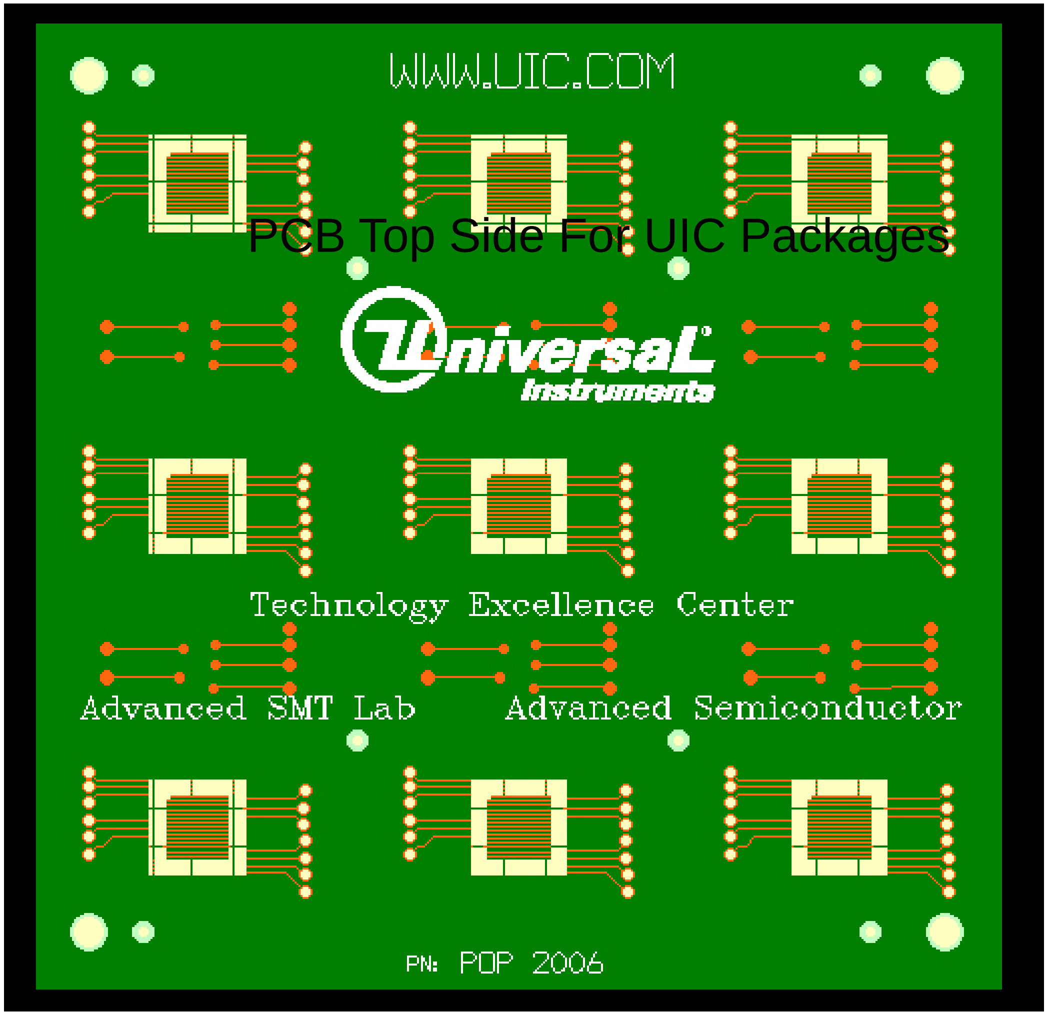


Top Package
(Bottom Surface w/ Balls and Fids)

A DOVER COMPANY

OK INTERNATIONAL

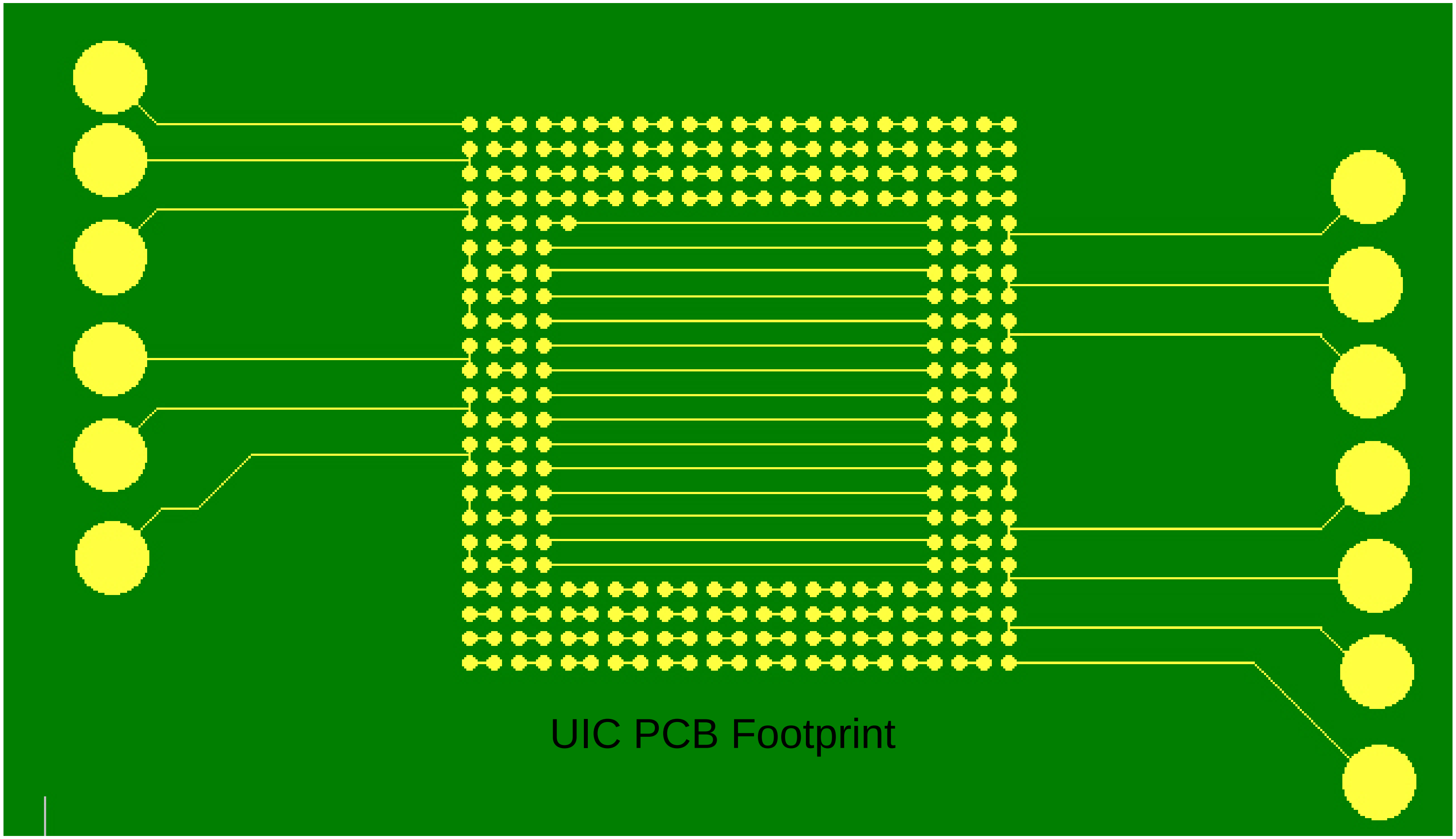
Demo POP PCB



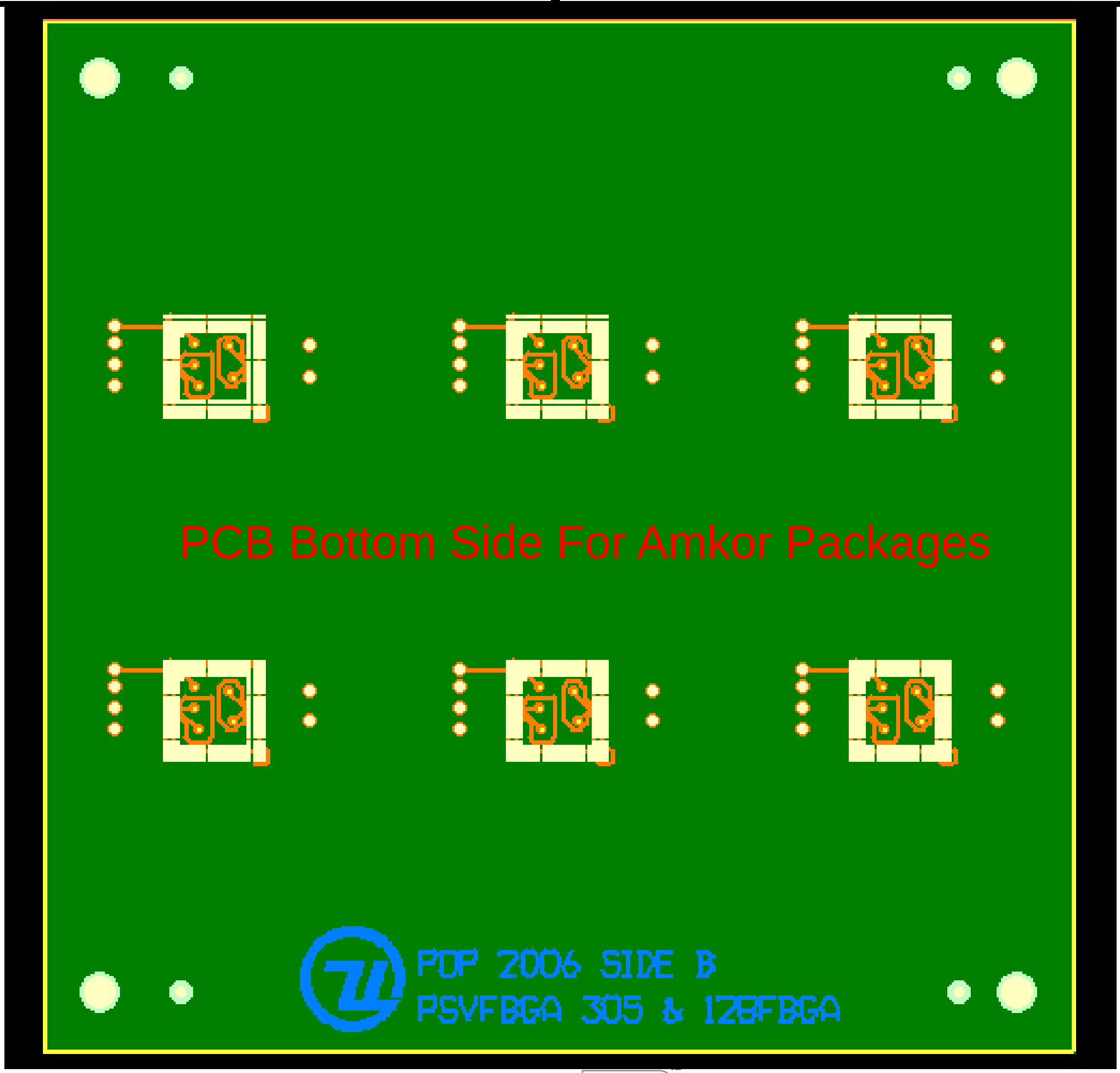
A DOVER COMPANY

OK INTERNATIONAL

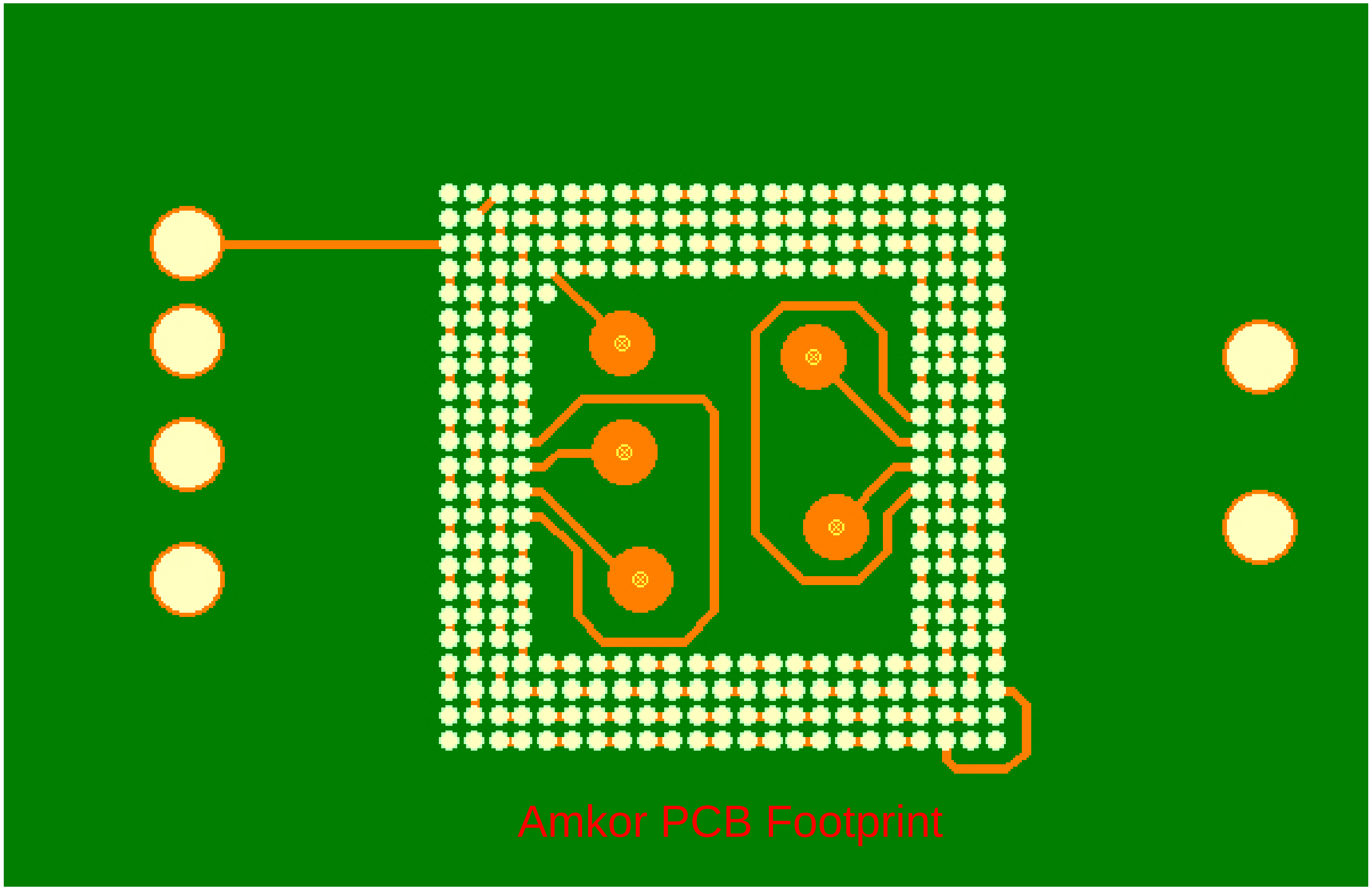
Demo Pcb layout



Back Of Demo PCB can use Amkor Practical components Packages



Amkor Pad layout Backside of Demo Pcb



Summary

Features	Advantages
Dual heaters allow lower reflow nozzle Air temperatures	Lower potential for BGA warping and POP is twice the mass so more heating is required
Dual heaters lower underside temp to 190^{0}C or below reflow on total underside of PCB area	Places less stress I.e. component stretching, PCB warping components' dropping off underside
Faster ramp and lower run time	Increases through-put, decreases costs Both in time and electricity.
All APRs will include dual heaters 2007	Differentiates our product (Patented) Patent no Us Patent no 6,897
All blowers in large & small heaters on during cooling stage	Faster cooling and conducive to PB-free solders, new faster cooling Specifications. .5-2deg per sec

Conclusion

- As Pb-free is adopted new challenges are introduced.
  - POP will also introduce more new challenges
  - Requirements for strict temperature control are Crucial for top to bottom temperatures' across the stacks.
- Equipment must:
  - Provide these higher levels of control
  - Dual heating will be a key advantage in the future.
  - Tweezer nozzles will be very important in POP.
- OKi offers innovative designs that improve processes and are easy to implement.