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Status Report on Assembly of Lead-Free Project Test Boards

Joint Group on Pollution Prevention
Joint Council on Aging Aircraft

Lety Campuzano-Contreras
Materials & Processes Engineer
BAE SYSTEMS Irving (TX)

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Objective

- The objective of this presentation is to provide status on the manufacture of the JG-PP/JCAA Joint Test Protocol assemblies and point to future activities.

Background

- Because of the drive in Asia and Europe for “green” electronic products, continued use of tin-lead solder presents business risks, including:
  - concerns about potential environmental legislation banning lead-containing products
  - risk of trade barriers and lost sales
  - reduced mission readiness
  - component obsolescence with lead surface finishes
- The Joint Group on Pollution Prevention began the Lead-Free Solder project in 2001 to have a better understanding of how some promising lead-free solder alloys perform when subjected to typical aerospace environmental conditions.
- JCAA joined JG-PP in May 1, 2003 because they saw the value of the lead-free solder project with regard to the numerous logistical and repair issues.
- Members of the combined team represent military services, NASA (**N**ational **A**eronautics and **S**pace **A**dministration), various defense, space and commercial contractors, and component and solder suppliers.

Background Continued

- To date, the project participants have:
  - Identified the performance requirements
  - Identified tests for lead-free solders
  - Identified the lead-free solder alternatives that would be tested
  - Completed design of the test circuit card
  - Assembled the 205 board test set and 92 SIR and EMR test boards
- Test set includes similar baseline tin-lead soldered boards.
- The materials were chosen based on initial environmental, safety, and occupational health screening data, as well as previous experience in Japan, Europe and other consortium using lead-free solders.

Background Continued

- The lead-free solder alloys agreed by the project stakeholders to be tested are as follows:
  - Tin-copper (stabilized) (99.3Sn-0.7Cu-0.05Ni) - wave and hand soldering
  - Tin-silver-copper (95.5Sn-3.9Ag-0.6Cu) - wave, reflow and hand soldering
  - Tin-silver-copper-bismuth (92.3Sn-3.4Ag-1.0Cu-3.3Bi) - reflow and hand soldering
- Rockwell Collins designed the test assembly and procured all components.
- BAE Systems Irving, formerly Boeing Commercial Electronics – Irving, agreed to assemble the test boards as our part in the consortium activities. Our facility and product were considered typical of factories producing a highly reliable product with enough volume to simulate a higher capacity production run.
- The project will generate critical reliability data on circuit cards manufactured and reworked with lead-free and eutectic tin-lead solders for military and space applications as documented in the Joint Test Protocol.

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Assembly Details

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Test Vehicle- Printed Wiring Assembly

PWB

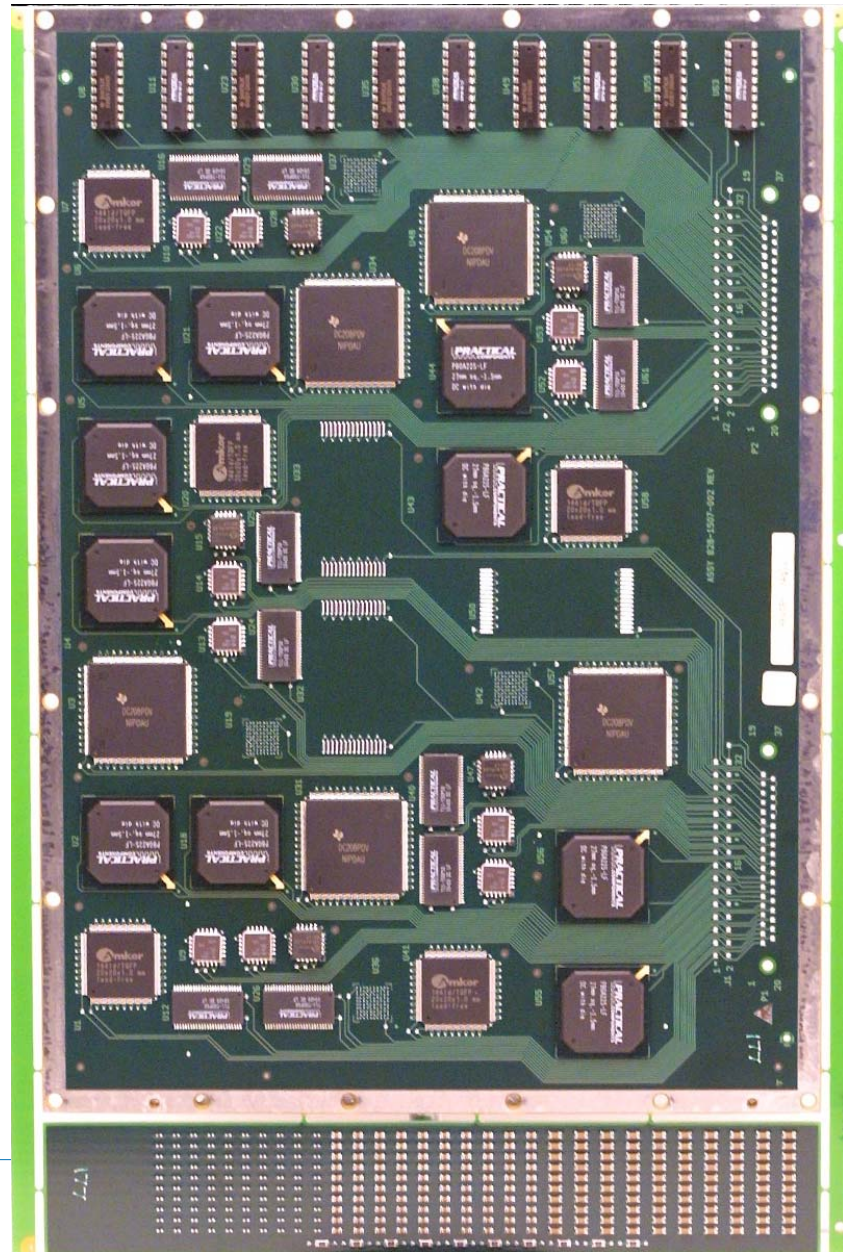
- 14.5”X 9”X 0.09”
- 6 layers
- Immersion Silver (Tg~170°C, GF- Pb-free PWAs)
- SnPb HASL (Tg~140°C, GF- Rework PWAs)

PWA

- Surface mount and through hole components
- Total Quantity: 205 (119/86)

Lead-Free Solder Alloys

- Sn3.9Ag0.6Cu (SnAgCu)
- Sn3.4Ag1.0Cu3.3Bi (SnAgCuBi)
- Sn0.7Cu (SnCu)



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Materials

Material	Wave Soldering	Reflow Soldering	Hand Soldering
Sn0.7Cu (stabilized)	X	N/A	Flux Cored Solder RMA (NoClean)
Flux	VOC Free No Clean Flux	N/A	R Heat Stabilized Resin ROL0 Tacky Flux
Sn3.9Ag0.6Cu	Sn3.5Ag.7Cu	X	Flux Cored Solder RMA
Flux	VOC Free No Clean Flux	ROL1	R Heat Stabilized Resin ROL0 Tacky Flux
Sn3.4Ag1Cu3.3Bi	N/A	Sn3.35Ag1Cu3.3Bi	0.010 Dia. Wire
Flux	N/A	No Clean (RMA)	R Heat Stabilized Resin ROL0 Tacky Flux
Sn37Pb	X	X	Flux Cored Solder RMA
Flux	Type ORM0	ROL0	ORL0 ROL0 Tacky Flux

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Components

Component Type	Component Finish
CLCC-20	SnPb
	SnAgCu
	SnAgCuBi
PLCC-20	Sn
TSOP-50	SnPb
	SnCu
TQFP-144	Sn
TQFP-208	NiPdAu
BGA-225	SnPb
	SnAgCu
DIP-20	Sn
	NiPdAu
0402Cap	Sn
0805Cap	Sn
1206Cap	Sn
1206Res	Sn

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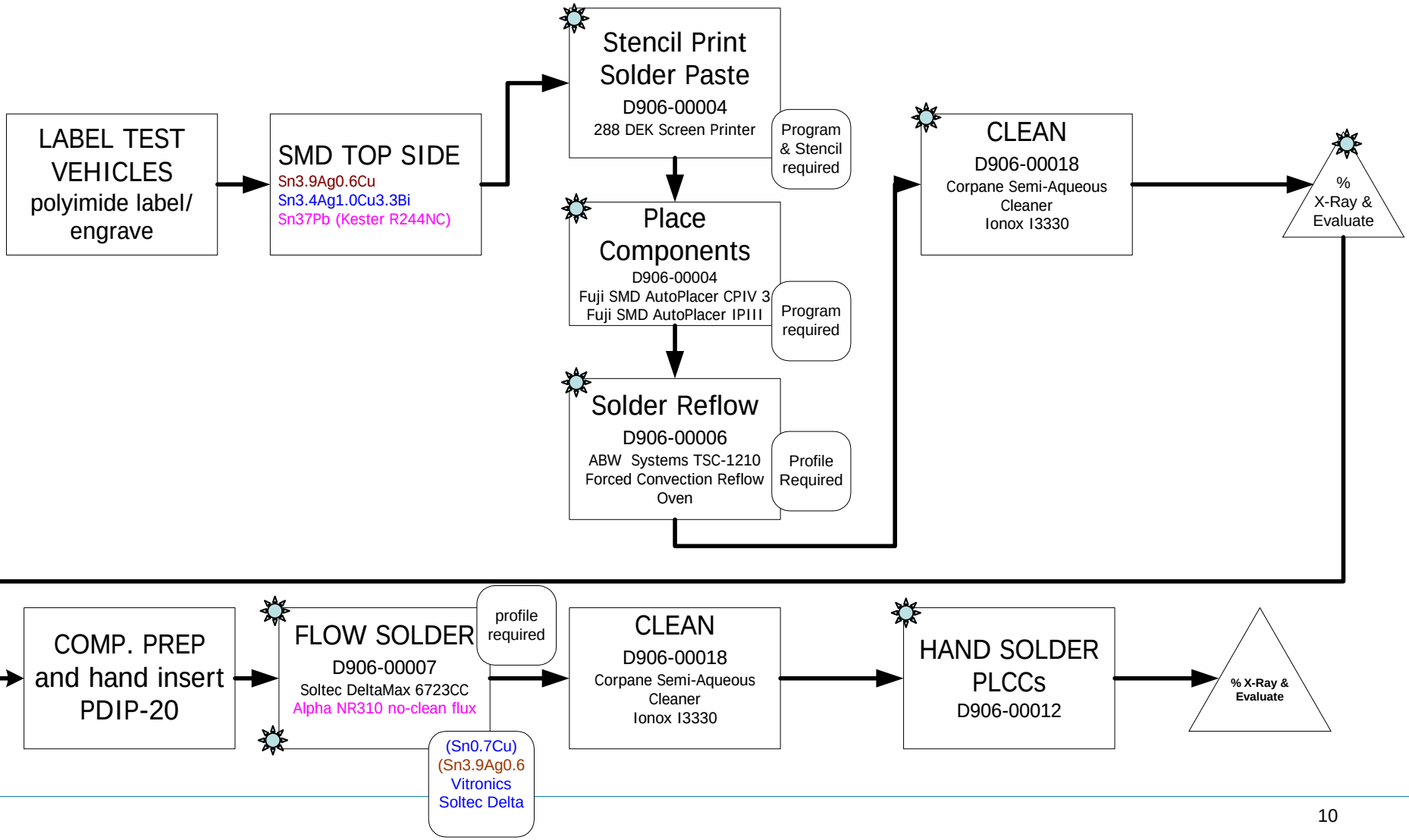
LEAD-FREE TEST VEHICLE ASSEMBLY FLOW

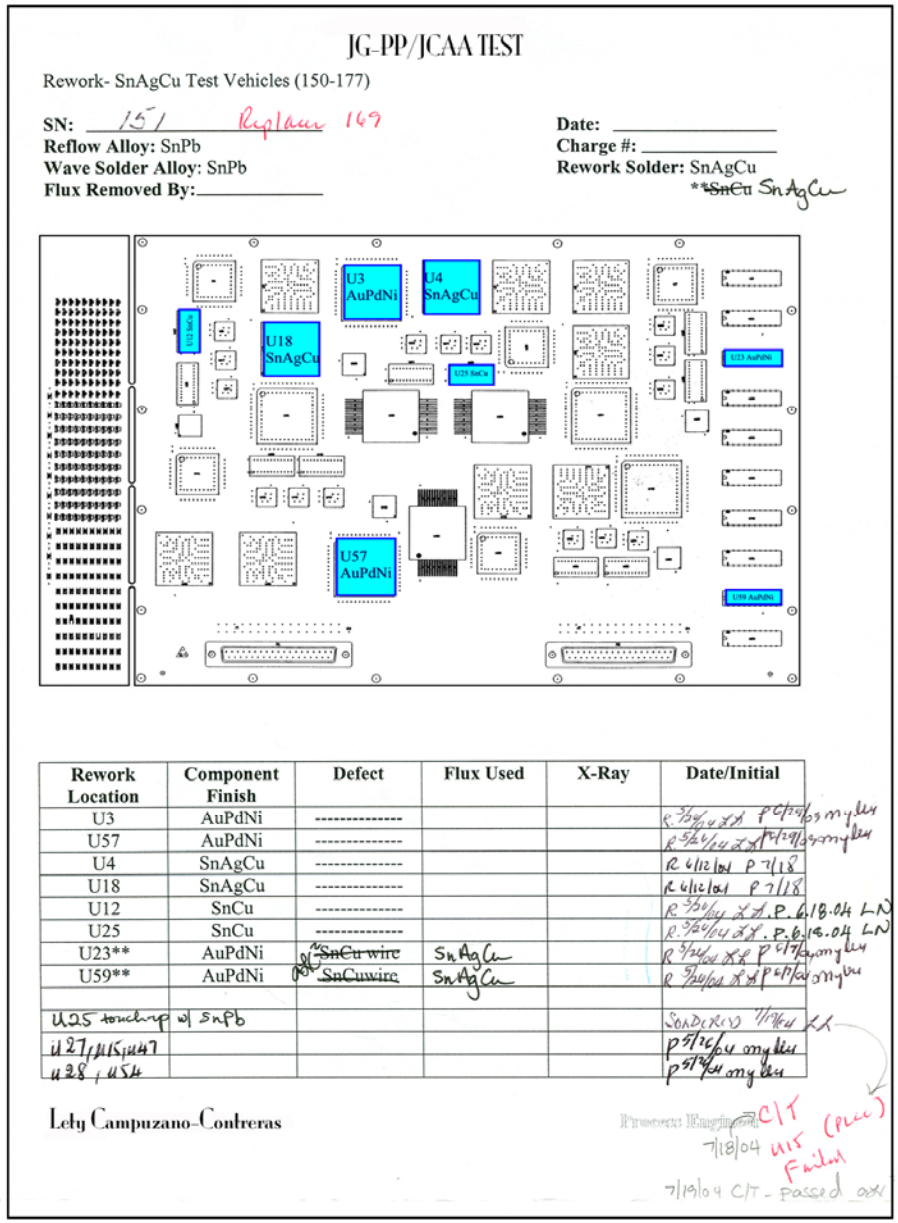


Assembly Notes

- All PLCCs were hand soldered with either SnPb, SnAgCu, or SnAgCuBi solder.
- Lead-Free wave solder with SnCu and SnAgCu was performed at Vitronics-Soltec in New Hampshire.
- After wave solder at Vitronics, the assemblies were cleaned at Kyzen in New Hampshire.

Production Environment

- Simulate production environment
- Full compliance to standard process control documents
- Formal planning sequence (CAAP)
- Certified operators and inspectors
- PE/QE special training for factory personnel
- Traveler used for serial number documentation



JG-PP/JCAA TEST

Rework- SnAgCu Test Vehicles (150-177)

SN: 151 Replace 169
Reflow Alloy: SnPb
Wave Solder Alloy: SnPb
Flux Removed By:

Date:
Charge #:
Rework Solder: SnAgCu
**~~SnCu~~ SnAgCu

Rework Location	Component Finish	Defect	Flux Used	X-Ray	Date/Initial
U3	AuPdNi	----------			R 5/26/04 LL P 6/29/03 myles
U57	AuPdNi	----------			R 5/26/04 LL P 6/29/03 myles
U4	SnAgCu	----------			R 6/12/04 P 7/18
U18	SnAgCu	----------			R 6/12/04 P 7/18
U12	SnCu	----------			R 5/26/04 LL. P. 6.18.04 LN
U25	SnCu	----------			R 5/26/04 LL. P. 6.18.04 LN
U23**	AuPdNi	~~SnCu wire~~	SnAgCu		R 5/26/04 LL P 6/7/04 myles
U59**	AuPdNi	~~SnCuwire~~	SnAgCu		R 5/26/04 LL P 6/7/04 myles
U25 touchup w/ SnPb					SONDERED 7/19/04 LL
U27, U15, U47					P 5/26/04 myles
U28, U54					P 5/26/04 myles

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Process Engineer C/T
7/18/04 U15 (PLCC) Failed
7/19/04 C/T - passed

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Rework

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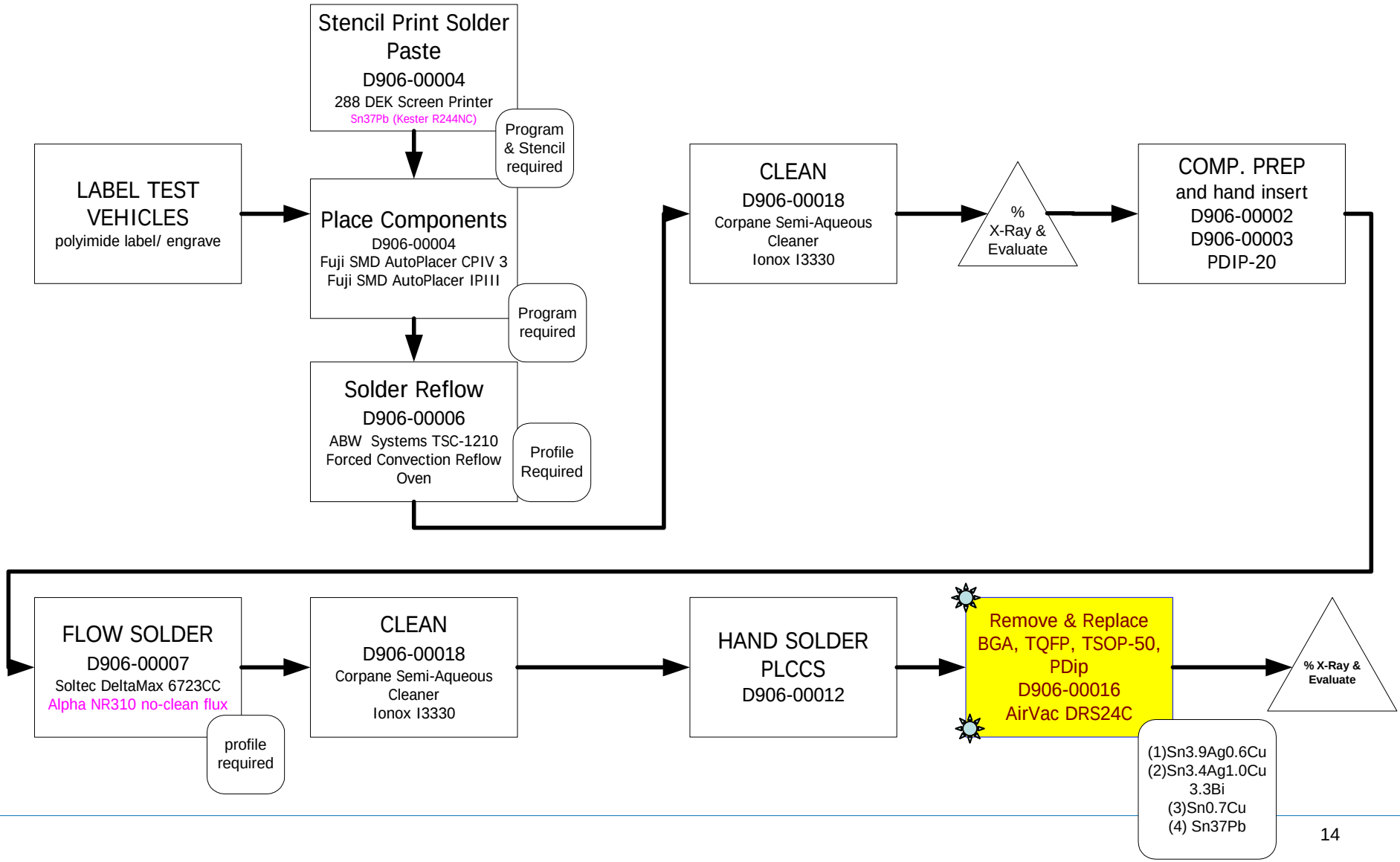
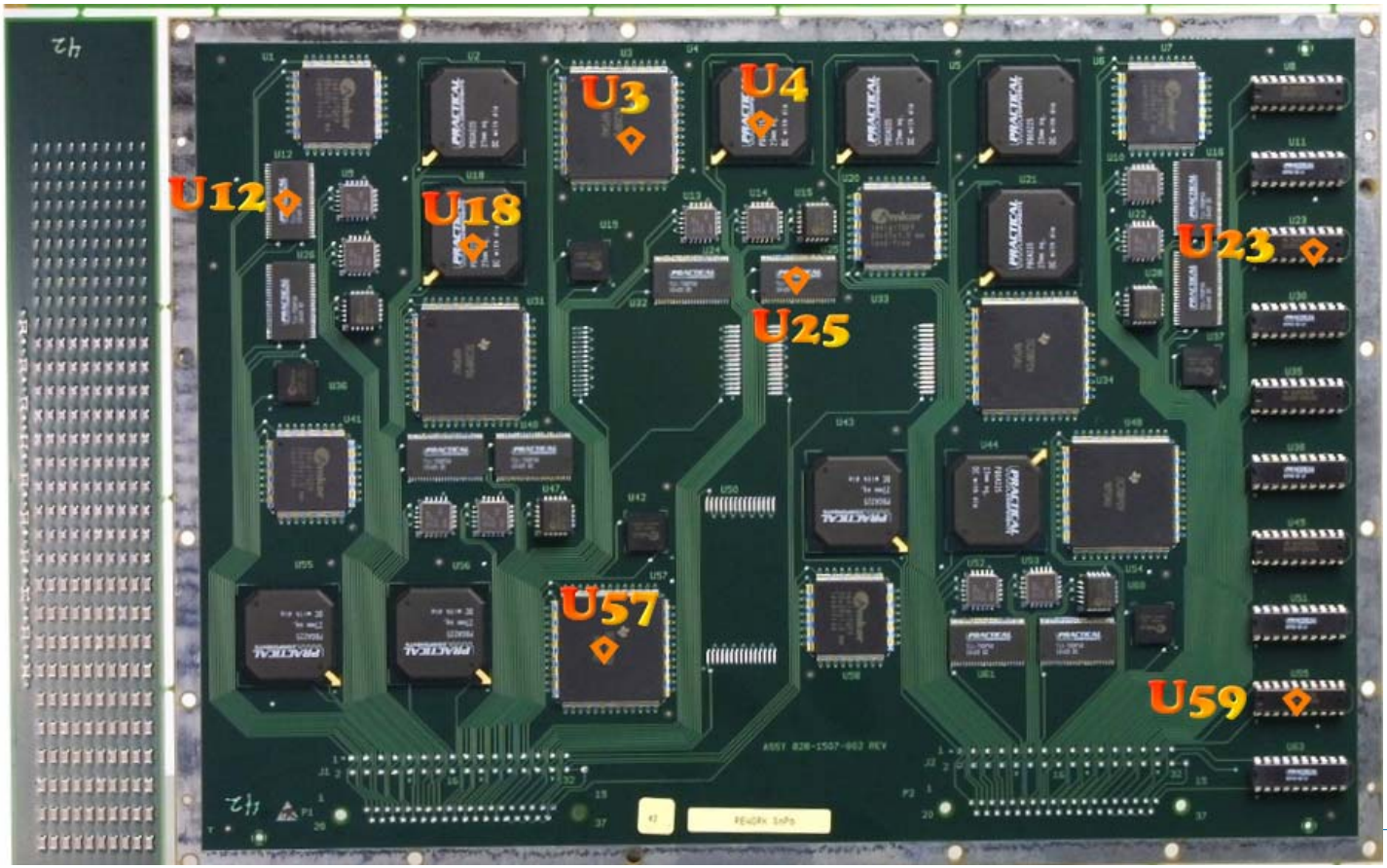
REWORK LEAD-FREE TEST VEHICLE ASSEMBLY FLOW



Rework Assemblies

Selected pairs of the following component types were removed and replaced to look at the effects on the assembly due to the additional and higher temperature and/or different solder joint metallurgy: BGA, TQFP-208, TSOP-50, DIP



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Rework *Control* Boards (SnPb solder initially; reworked with SnPb solder)

Location	Part Number	Qty Per Board	Part Finish Before Rework	Replacement Part Finish
U25	TSOP-50	1	SnPb	SnPb
U12	TSOP-50	1	SnPb	SnPb
U57	TQFP-208	1	NiPdAu	NiPdAu
U3	TQFP-208	1	NiPdAu	NiPdAu
U18	BGA-225	1	SnPb	SnPb
U4	BGA-225	1	SnPb	SnPb
U59	DIP-20	1	NiPdAu	NiPdAu
U23	DIP-20	1	NiPdAu	NiPdAu

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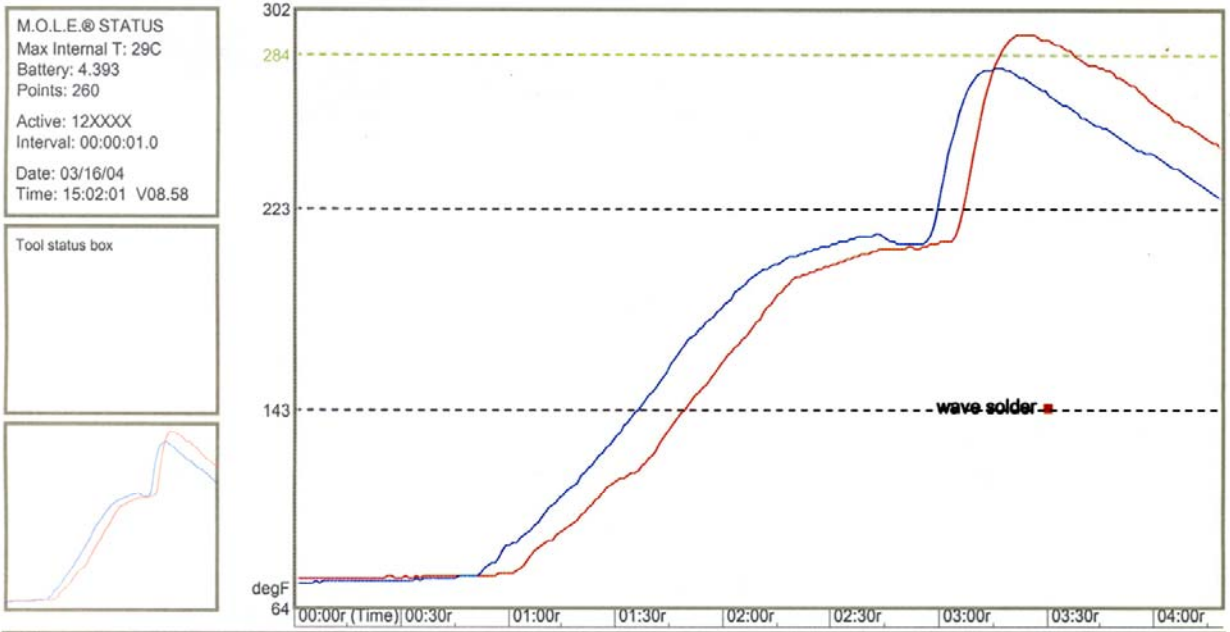
Rework Boards (SnPb solder initially; reworked with SnAgCu or SnAgCuBi solder)

Location	Part Number	Qty Per Board	Part Finish Before Rework	Replacement Part Finish
U25	TSOP-50	1	SnPb	SnCu
U12	TSOP-50	1	SnPb	SnCu
U57	TQFP-208	1	NiPdAu	NiPdAu
U3	TQFP-208	1	NiPdAu	NiPdAu
U18	BGA-225	1	SnPb	SnAgCu
U4	BGA-225	1	SnPb	SnAgCu
U59	DIP-20	1	NiPdAu	NiPdAu
U23	DIP-20	1	NiPdAu	NiPdAu

Tin Lead Solder (SnPb)

Wave Solder SnPb Profile (Rework & Manufactured-Control)



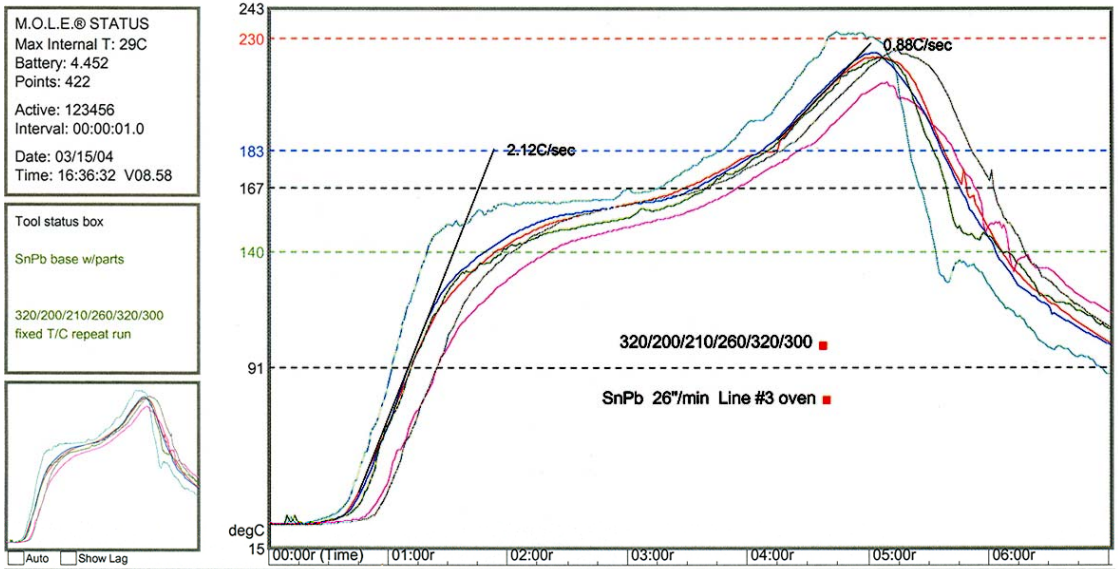
	Value	C1 = 00:00:51r	C2 = 00:01:42r	C3 = 00:02:33r	C4 = 00:03:24r	Units
•	t/x#1 trailing edge of pwb	77	130	202	292	degF
•	t/c#2 center of pwb	77	154	210	274	degF

	T Above Ref	Low = 284	Med = 361	Hi = 446	Cure Factor	Units
•	t/x#1 trailing edge of pwb	00:00:21	00:00:00	00:00:00	0%	degF
•	t/c#2 center of pwb	00:00:00	00:00:00	00:00:00	0%	degF

Typical SnPb Profile

Solder Pot Temperature = 250°C
Preheat Board T = 101°C
Peak Temperature = 144°C
Speed: 110 cm/min

Reflow Oven SnPb Solder Profile (Rework & Manufactured-Control)



	Value	C1 = 00:01:24r	C2 = 00:02:48r	C3 = 00:04:12r	C4 = 00:05:36r	Units
•	t/c11 embedded U2 bga	114	158	182	185	degC
•	t/c7 embedded U42 csp	119	158	186	183	degC
•	t/c3 topside laminate U44 bga	114	153	184	174	degC
•	t/c8 embedded U44 bga	91	148	176	190	degC
•	t/c5 topside laminate U42 csp	148	162	198	130	degC
•	t/c9 embedded U37 csp	91	158	181	211	degC

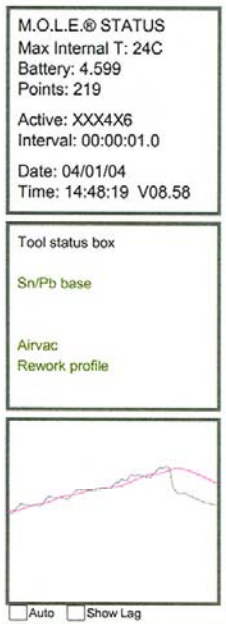
	T Above Ref	Low = 140	Med = 183	Hi = 230	Cure Factor	Units
•	t/c11 embedded U2 bga	00:04:14	00:01:24	00:00:00	0%	degC
•	t/c7 embedded U42 csp	00:04:16	00:01:30	00:00:00	0%	degC
•	t/c3 topside laminate U44 bga	00:04:12	00:01:23	00:00:00	0%	degC
•	t/c8 embedded U44 bga	00:03:50	00:01:18	00:00:00	0%	degC
•	t/c5 topside laminate U42 csp	00:04:14	00:01:34	00:00:23	0%	degC
•	t/c9 embedded U37 csp	00:04:16	00:01:35	00:00:00	0%	degC

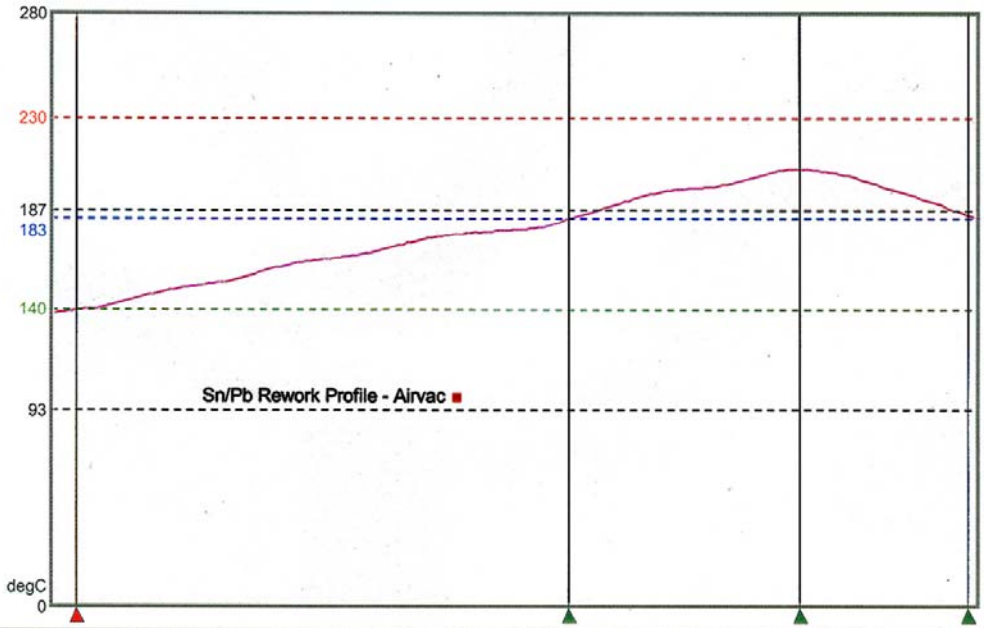
	Statistics	Minimum	Minimum X	Maximum	Maximum X	Average	Std Deviation	Units
•	t/c11 embedded U2 bga	25	00:00:00r	222	00:05:02r	140.7	55.4	degC
•	t/c7 embedded U42 csp	25	00:00:04r	224	00:05:01r	140.6	55.3	degC
•	t/c3 topside laminate U44 bga	26	00:00:00r	222	00:05:04r	138.4	54.0	degC
•	t/c8 embedded U44 bga	26	00:00:00r	212	00:05:09r	133.2	54.4	degC
•	t/c5 topside laminate U42 csp	25	00:00:00r	233	00:04:44r	143.3	56.8	degC
•	t/c9 embedded U37 csp	25	00:00:00r	225	00:05:14r	139.4	59.5	degC

Standard SnPb Profile

Preheat = ~ 120 seconds @140-183°C
Peak temperature = 225°C
Time above reflow = 60-90 sec
Ramp Rate = 2-3 °C/sec

AIR-VAC DRS24C.2D SnPb Rework Profile for BGA Removal & Replacement





	Value	C1 = 00:00:06r	C2 = 00:02:02r	C3 = 00:02:56r	C4 = 00:03:35r	Units
▫	open					
▫	open					
▫	open					
▪	t/c4 under U2 BGA	140	183	206	184	degC
▫	open					
▫	t/c6 topside U2					

	T Above Ref	Low = 140	Med = 183	Hi = 230	Cure Factor	Units
▫	open					
▫	open					
▫	open					
▪	t/c4 under U2 BGA	00:03:32	00:01:36	00:00:00	0%	degC
▫	open					
▫	t/c6 topside U2					

Standard SnPb Rework Profile

Preheat = ~ 120 seconds @140-183°C
Ball Peak temperature = 206°C
Time above reflow = 96 seconds
Ramp Rate = 2-3 °C/sec

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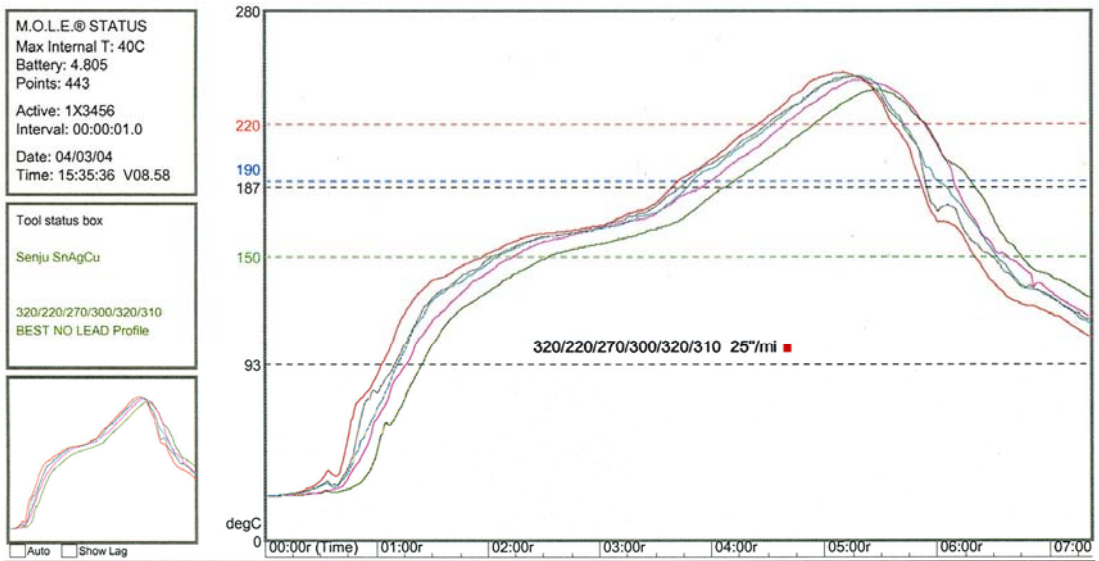
Tin-Silver-Copper (SnAgCu) and Tin-Silver-Copper-Bismuth (SnAgCuBi)

Reflow Oven Lead-Free Solder (SnAgCu & SnAgCuBi) Profile



Value	C1 = 00:02:13r	C2 = 00:03:59r	C3 = 00:04:38r	C4 = 00:05:53r	Units
t/c11topside U41	158	201	230	183	degC
t/c2 under U44 BGA					
t/c24 topside U44	141	182	208	221	degC
t/c4 under U2 BGA	150	190	219	220	degC
t/c5 topside U57	154	197	225	198	degC
t/c6 topside U2	155	199	227	191	degC

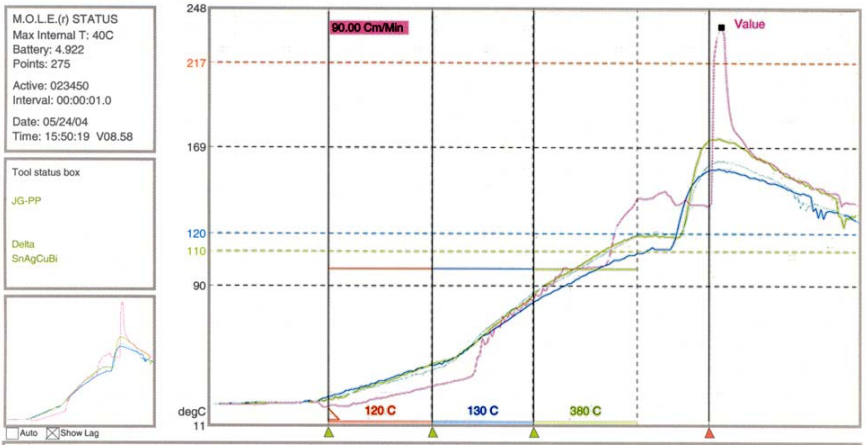
T Above Ref	Low = 150	Med = 190	Hi = 220	Cure Factor	Units
t/c11topside U41	00:04:23	00:02:09	00:01:12	0%	degC
t/c2 under U44 BGA					
t/c24 topside U44	00:04:13	00:02:06	00:01:00	0%	degC
t/c4 under U2 BGA	00:04:25	00:02:10	00:01:15	0%	degC
t/c5 topside U57	00:04:27	00:02:11	00:01:11	0%	degC
t/c6 topside U2	00:04:29	00:02:08	00:01:13	0%	degC

Statistics	Minimum	Minimum X	Maximum	Maximum X	Average	Std Deviation	Units
t/c11topside U41	23	00:00:00r	248	00:05:10r	155.4	60.2	degC
t/c2 under U44 BGA							
t/c24 topside U44	23	00:00:00r	238	00:05:26r	148.2	63.2	degC
t/c4 under U2 BGA	24	00:00:00r	243	00:05:15r	153.1	63.2	degC
t/c5 topside U57	24	00:00:00r	246	00:05:12r	154.1	62.0	degC
t/c6 topside U2	23	00:00:00r	245	00:05:13r	154.4	61.0	degC

Based on consortium agreed requirements:

Preheat = 60-120 seconds @150-190°C
Peak temperature target = 243°C
Reflow:
~20 seconds above 230°C
~30-90 seconds above 220°C

Lead-Free Solder Wave Solder Profile



Value	C1 = 00:00:00r	C2 = 00:00:41r	C3 = 00:01:21r	C4 = 00:02:30r	Units
Top on U44	27	45	81	156	degC
Top U35	26	46	85	173	degC
Bottom Near U41	22	33	82	136	degC
Top U41	26	42	86	159	degC

Time To Ref	Low = 110	Med = 120	Hi = 217		Units
Top on U44	00:02:06	00:02:18			Time
Top U35	00:01:48	00:02:20			Time
Bottom Near U41	00:01:52	00:01:53	00:02:32		Time
Top U41	00:01:51	00:02:05			Time

T Above Ref	Low = 110	Med = 120	Hi = 217	Cure Factor	Units
Top on U44	00:01:24	00:01:12	00:00:00	0%	Time
Top U35	00:01:42	00:01:10	00:00:00	0%	Time
Bottom Near U41	00:01:38	00:01:37	00:00:05	0%	Time
Top U41	00:01:39	00:01:22	00:00:00	0%	Time

Statistics	Minimum	Minimum X	Maximum	Maximum X	Average	Std Deviation	Units
Top on U44	23	00:00:47r	157	00:02:34r	82.1	47.7	degC
Top U35	23	00:00:47r	174	00:02:34r	86.2	52.1	degC
Bottom Near U41	21	00:00:02r	238	00:02:35r	86.2	58.2	degC
Top U41	23	00:00:47r	162	00:02:34r	83.7	49.2	degC

Summary Stats	Peak	Minimum	Max (+)Slope	Max (-)Slope	Time Above 21	Time 217C-300	217C / Peak	Peak \ 217C
							0.00	0.00
Top on U44	157.2	22.8	5.33	-2.67	0.0	0.0	0.00	0.00
Top U35	174.4	22.8	7.33	-3.67	0.0	0.0	0.00	0.00
Bottom Near U41	237.8	21.1	20.44	-11.78	5.0	0.0	2.57	5.14
Top U41	161.7	22.8	5.11	-2.56	0.0	0.0	0.00	0.00
							0.00	0.00
Range	80.6	1.7	15.33	9.22	5.0	0.0	0.00	0.00

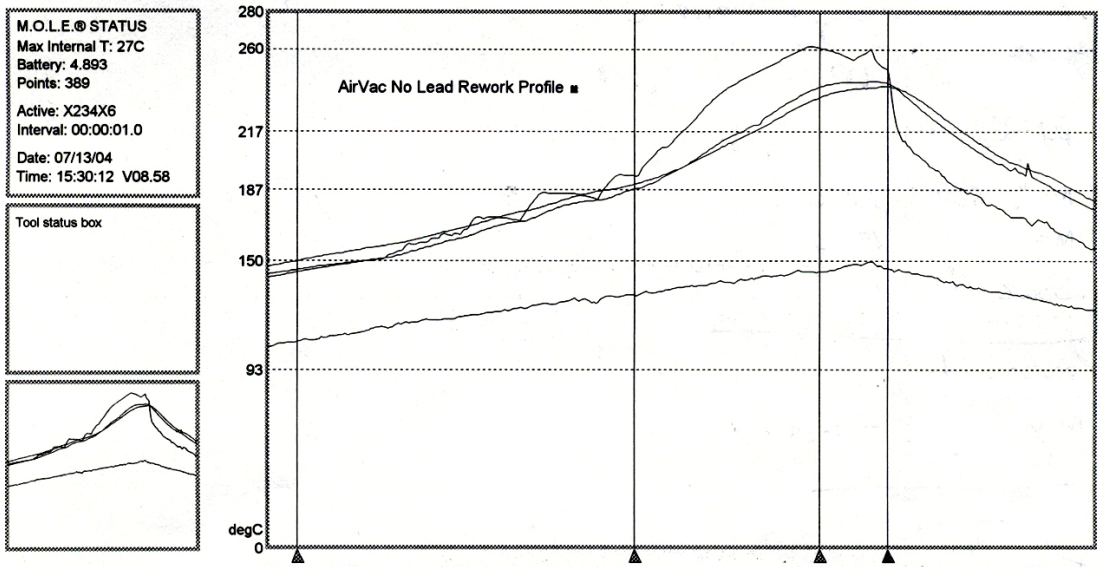
Solder Pot Temperature = 265°C for SnCu

Preheat Board T = 134°C
Peak Temperature = 157°C
Speed: 90 cm/min

Solder Pot Temperature = 260°C for SnAgCu
Preheat Board T = 136°C
Peak Temperature = 161°C
Speed: 90 cm/min

Profile provided by Vitronics-Soltec

AIR-VAC DRS24C.2D Lead-Free Rework Profile for BGA Replacement



Value	C1 = 00:00:14r	C2 = 00:02:52r	C3 = 00:04:19r	C4 = 00:04:50r	Units
open					
t/c2 top of U2 body	146	194	261	249	degC
board surface	108	132	144	146	degC
t/c4 under U2 BGA in pad	150	190	235	241	degC
open					
t/c6 topside under U2	144	187	241	242	degC

T Above Ref	Low = 150	Med = 217	Hi = 260	Cure Factor	Units
open					
t/c2 top of U2 body	00:05:44	00:01:41	00:00:14	0%	degC
board surface	00:00:00	00:00:00	00:00:00	0%	degC
t/c4 under U2 BGA in pad	00:06:14	00:01:37	00:00:00	0%	degC
open					
t/c6 topside under U2	00:05:43	00:01:36	00:00:00	0%	degC

Statistics	Minimum	Minimum X	Maximum	Maximum X	Average	Std Deviation	Units
open							
t/c2 top of U2 body	143	00:00:00r	262	00:04:13r	192.7	37.1	degC
board surface	105	00:00:00r	149	00:04:41r	129.9	11.7	degC
t/c4 under U2 BGA in pad	147	00:00:00r	241	00:04:46r	193.3	28.4	degC
open							
t/c6 topside under U2	141	00:00:00r	243	00:04:41r	190.9	31.4	degC

Device joint target = 243°C
Device top max target = 260°C
Board target = 110°C (process starting point)
Board max = 150°C
Reflow:
~97 seconds above 217°C
~75 seconds above 221°C
~44 seconds above 235°C
Ball temperature 241°C
Ramp rate 1.14°C/sec

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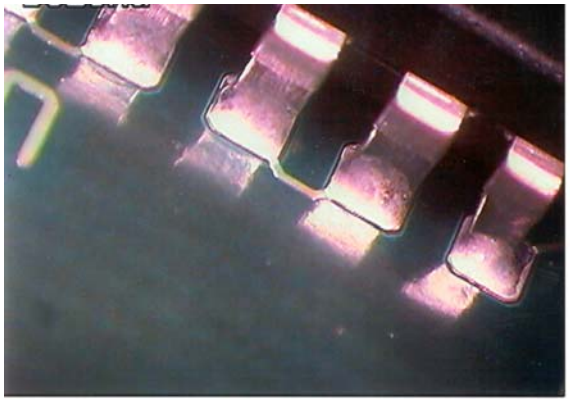
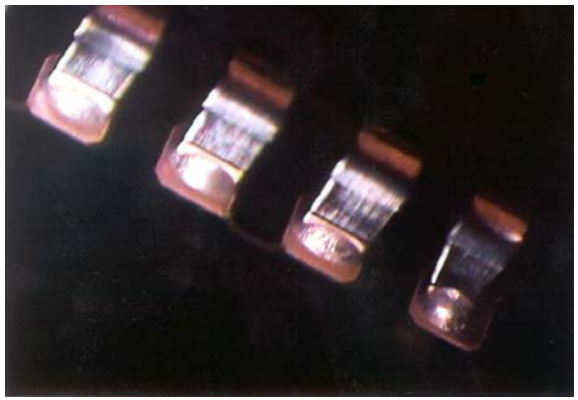
Results

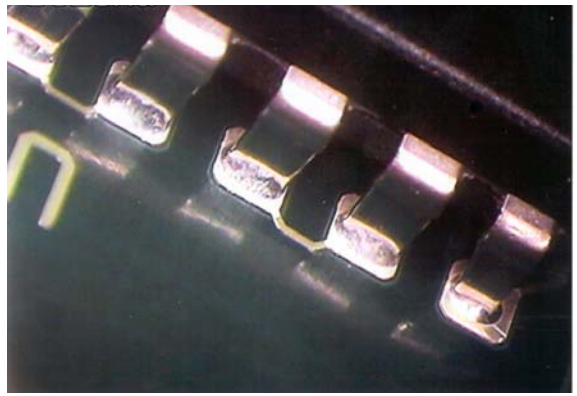
Comparison of NiPdAu DIPs wave soldered with SnPb, SnCu, or SnAgCu



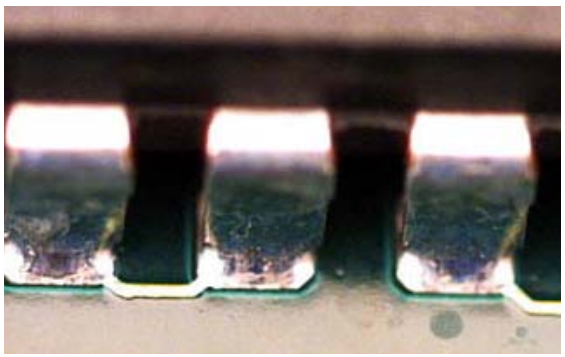
SN10: U35 with SnPb



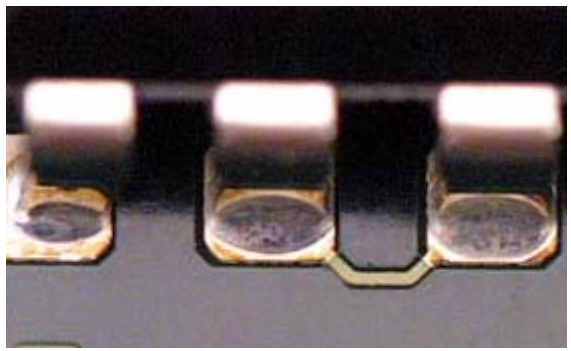
SN121: U35 with SnCu



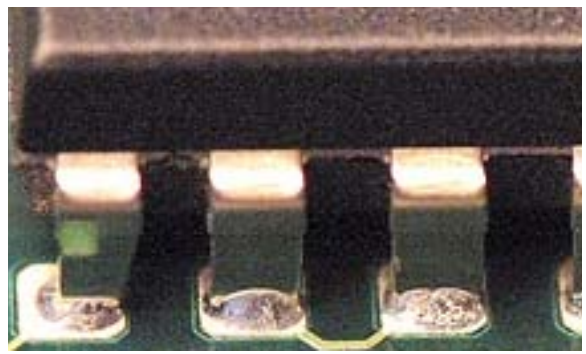
SN80: U35 with SnAgCu



SN41: U59 with SnPb

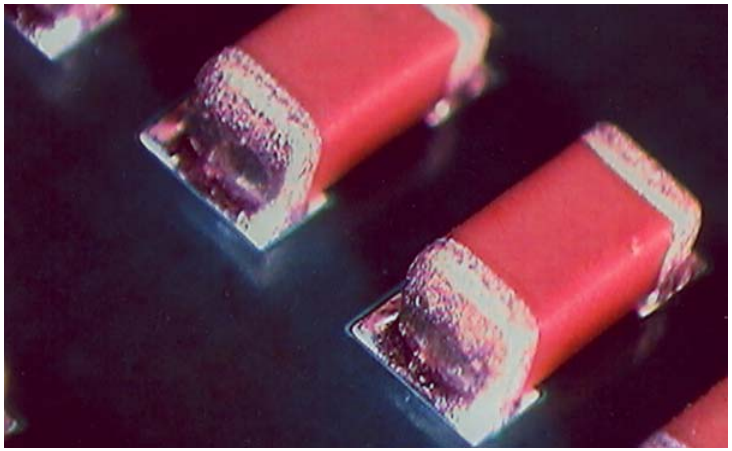


SN138:U59 with SnCu

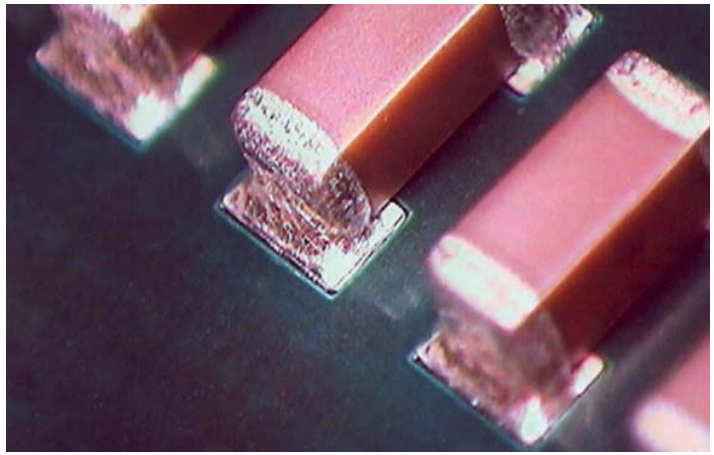


SN110: U59 with SnAgCu

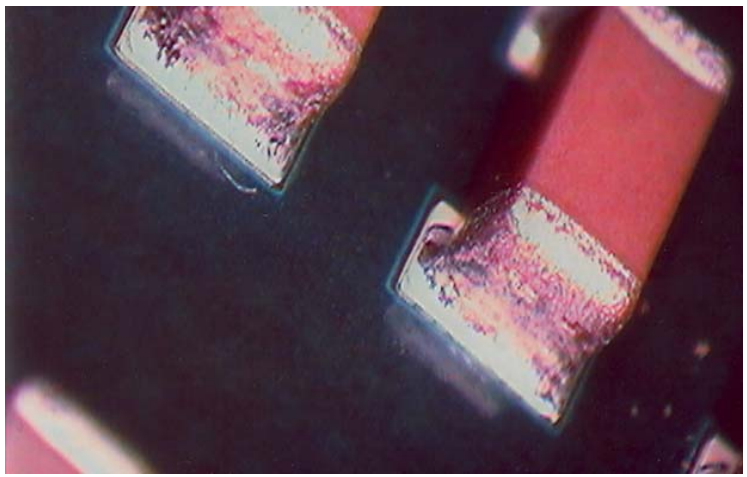
Comparison of 0805 Capacitors soldered with SnPb, SnAgCu and SnAgCuBi



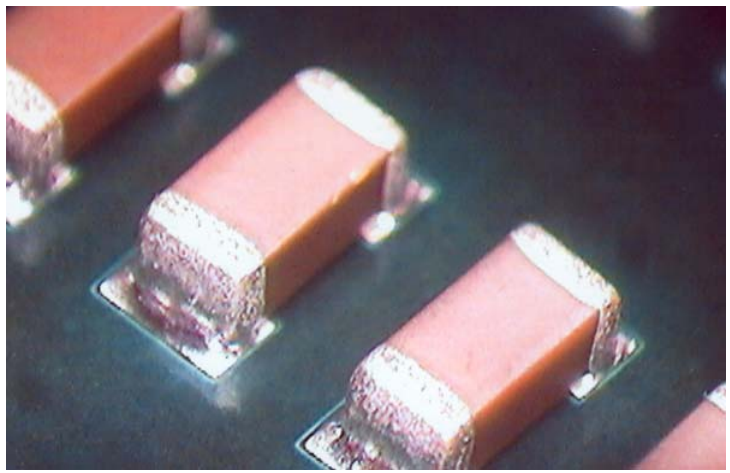
SN40 Sn/SnPb, Immersion Ag PWB



SN137 Sn/SnAgCuBi, Immersion Ag PWB



SN105 Sn/SnAgCu, Immersion Ag PWB



SN34 SnPb/SnPb, SnPb HASL PWB

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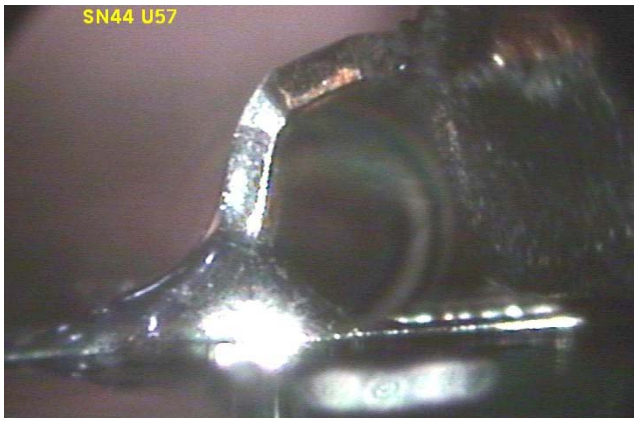
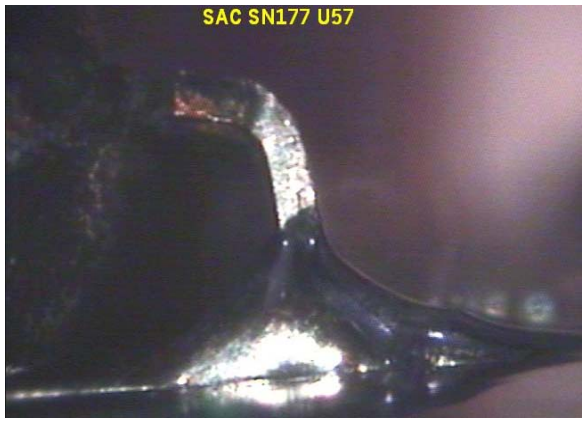
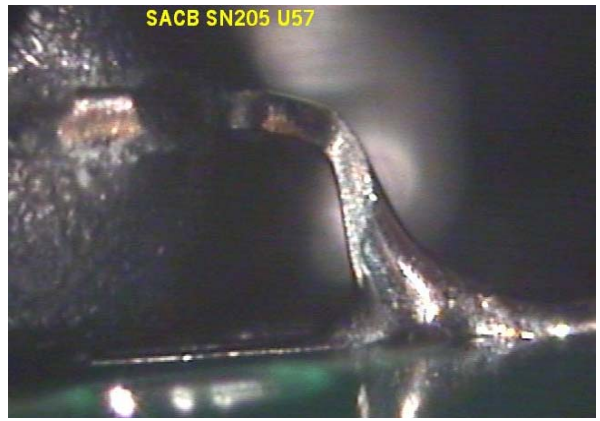
Comparison of TQFP-208 replaced with SnPb, SnAgCu and SnAgCuBi



SN44 U57 reworked with SnPb



SN177 reworked with SnAgCu

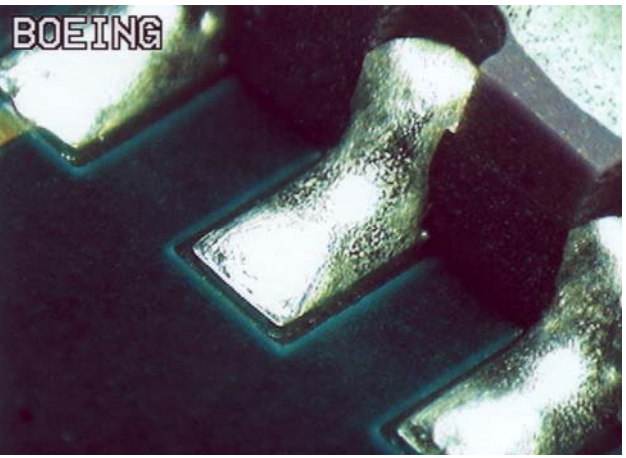


SN205 reworked with SnAgCuBi

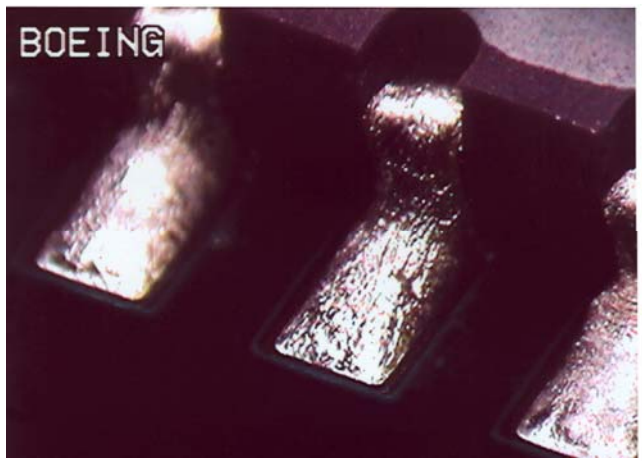
SnPb HASL PWB

BAE SYSTEMS

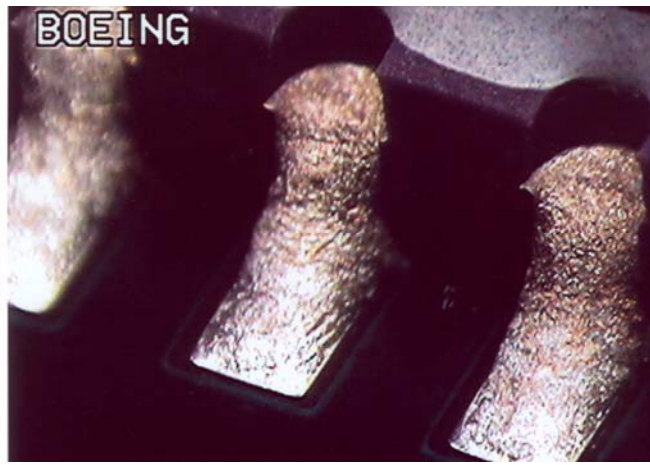
Comparison of different surface finish CLCCs soldered with SnPb, SnAgCu, and SnAgCuBi



SN44 U17
SnPb lead surface finish
soldered with SnPb



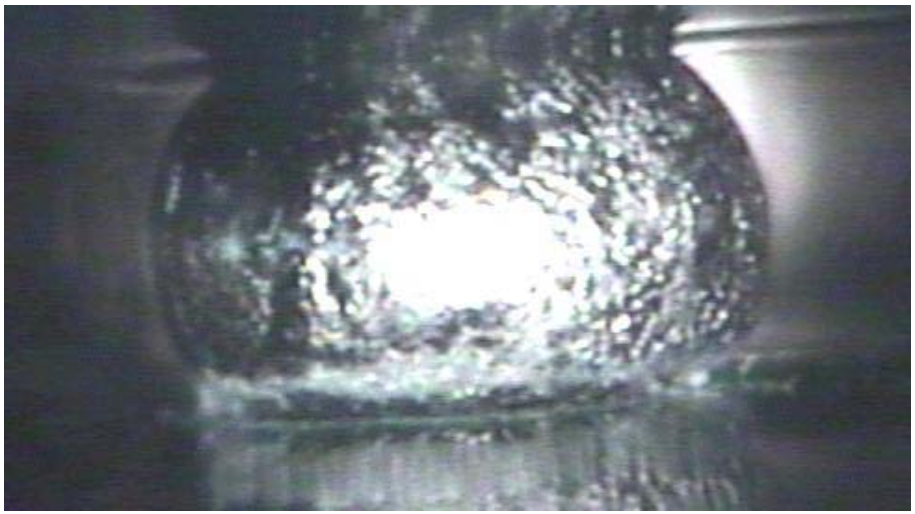
SN156 U17
SnAgCu lead surface finish
soldered with SnPb



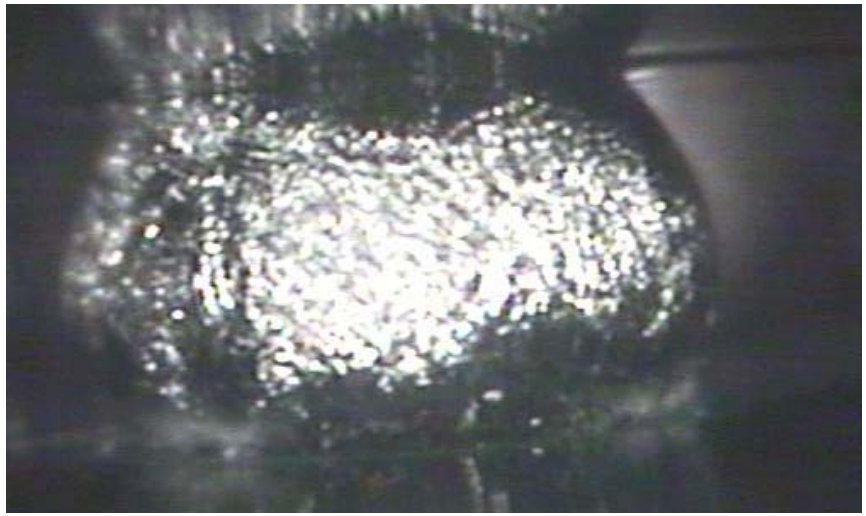
SN182 U17
SnAgCuBi lead surface finish
soldered with SnPb

SnPb HASL PWB

Comparison of SnAgCu BGA and SnPb BGA soldered with SnAgCu.



SN110 U56 SnPb soldered with SnAgCu
Immersion Ag PWB
Lead-Free Reflow Profile

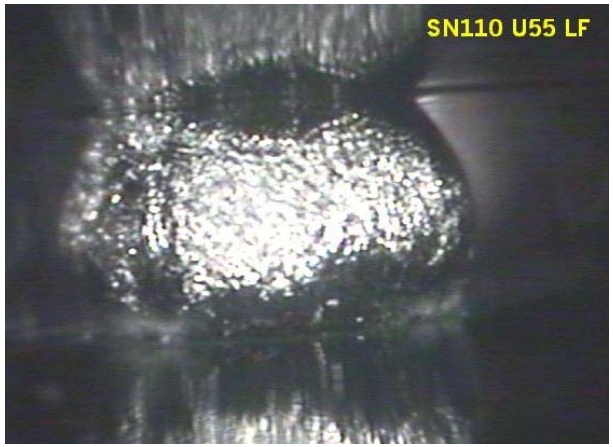


SN110 U55 SnAgCu soldered with SnAgCu
Immersion Ag PWB
Lead-Free Reflow Profile

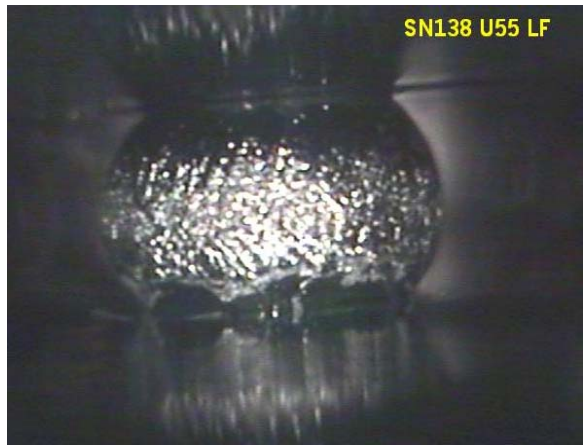
BAE SYSTEMS

Comparison of SnAgCu BGA soldered with SnPb, SnAgCu, and SnAgCuBi

SN205 U56 (SnAgCu)
SnPb solder
SnPb HASL PWB
SnPb Reflow Profile



SN110 U55 (SnAgCu)
SnAgCu solder
Immersion Ag PWB
Lead-Free Reflow Profile

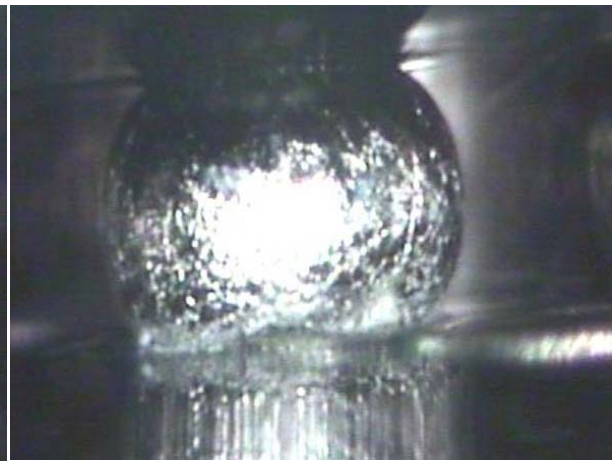


SN138 U55 (SnAgCu)
SnAgCuBi solder
Immersion Ag PWB
Lead-Free Reflow Profile

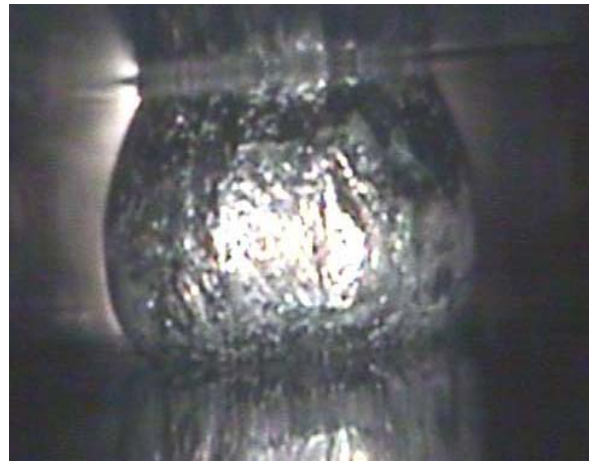
BAE SYSTEMS

Comparison of SnPb BGAs soldered with SnPb, SnAgCu and SnAgCuBi

SN44 U56
soldered with SnPb.



SN110 U56
soldered with SnAgCu.



SN138 U56
soldered with SnAgCuBi.

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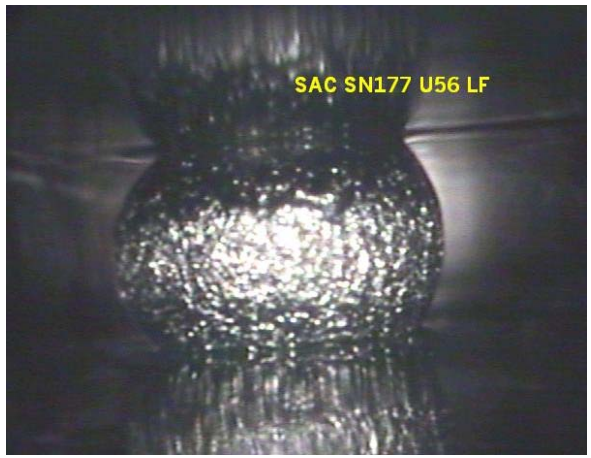
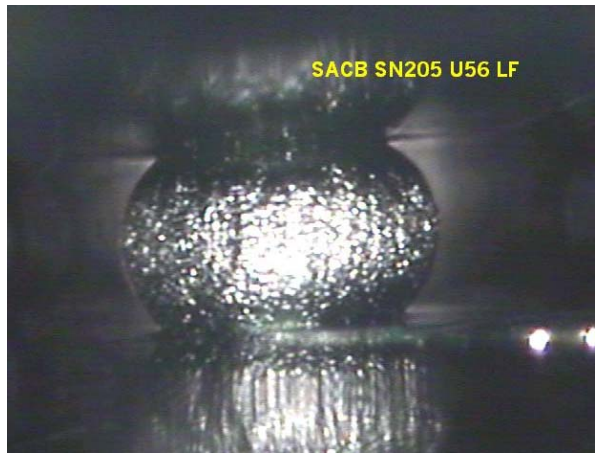
Comparison of BGAs soldered with SnPb Solder and reflow profile

SN44 SnPb Rework-Control
SnPb BGA: SnPb solder



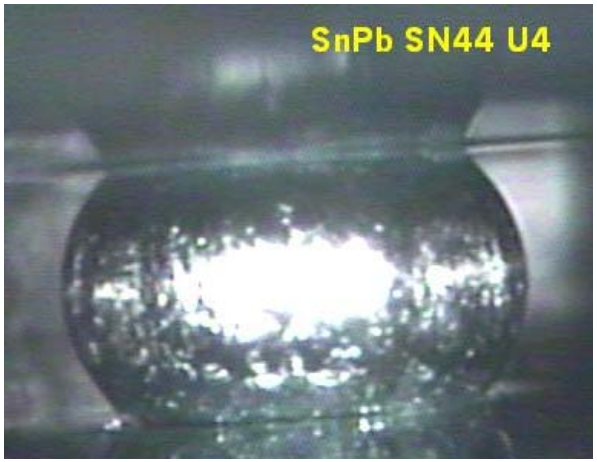
SN177 SnAgCu Rework
SnAgCu BGA: SnPb solder



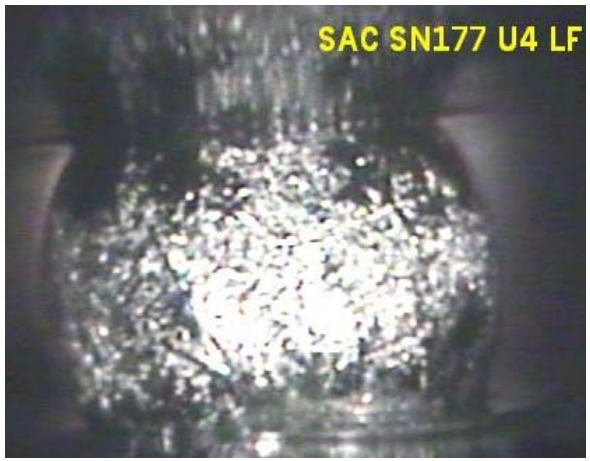
SN205 SnAgCuBi Rework
SnAgCu BGA: SnPb solder

SnPb HASL PWB

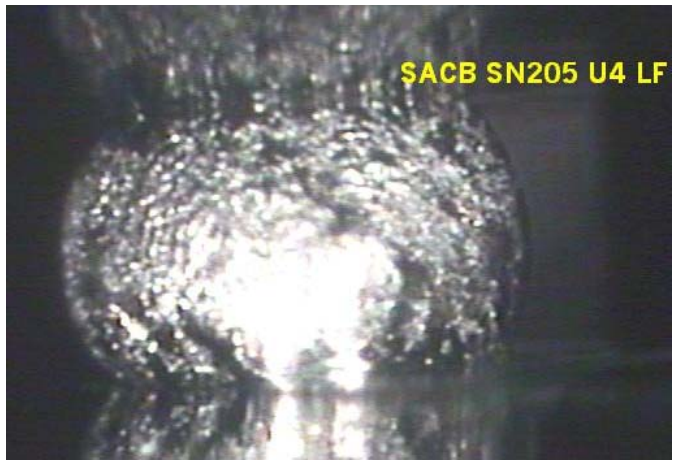
Comparison of reworked BGAs



SN44 U4
SnPb BGA reflowed



SN177 U4
SnAgCu BGA reflowed



SN205 U4
SnAgCu BGA reflowed

SnPb HASL PWB and Lead-Free Reflow Profile

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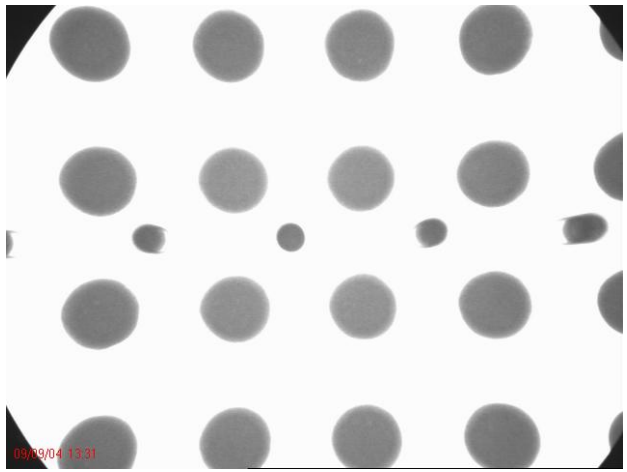
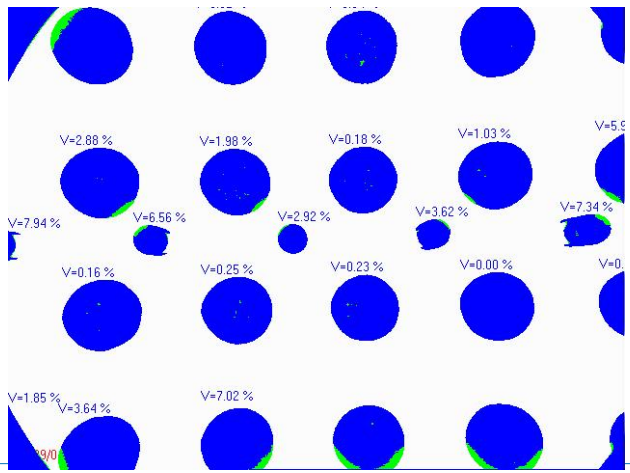
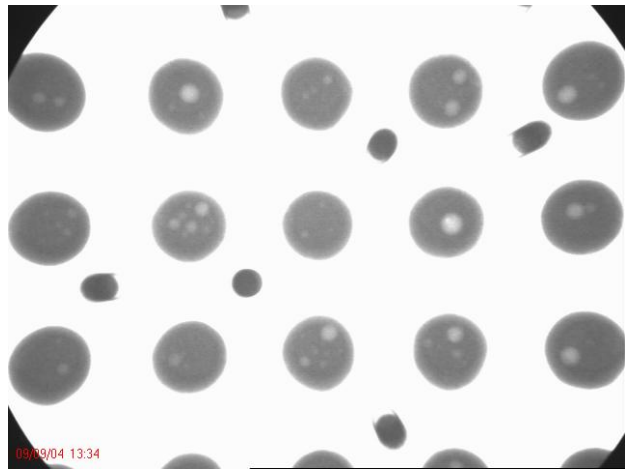
Comparison of void percent between SnAgCu and SnPb BGAs soldered with SnAgCu solder

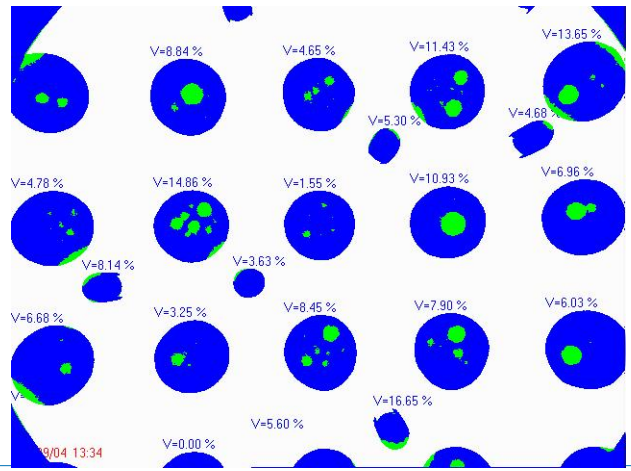
SN110 U55 LF





SN110 U56 Pb
2-15 void percent

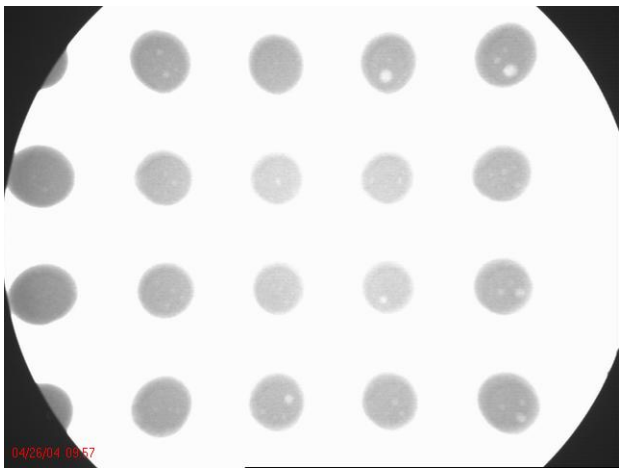


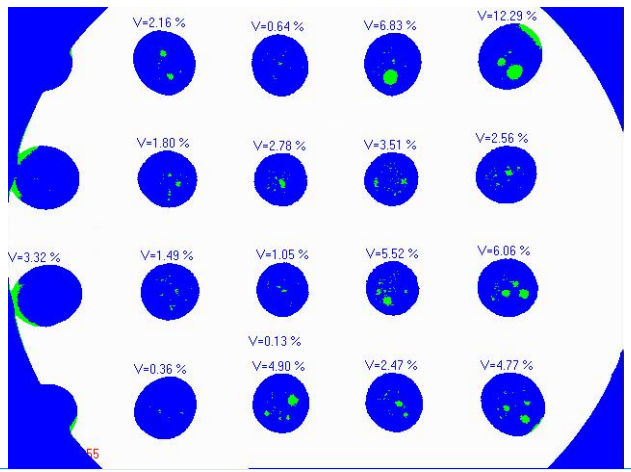


BAE SYSTEMS

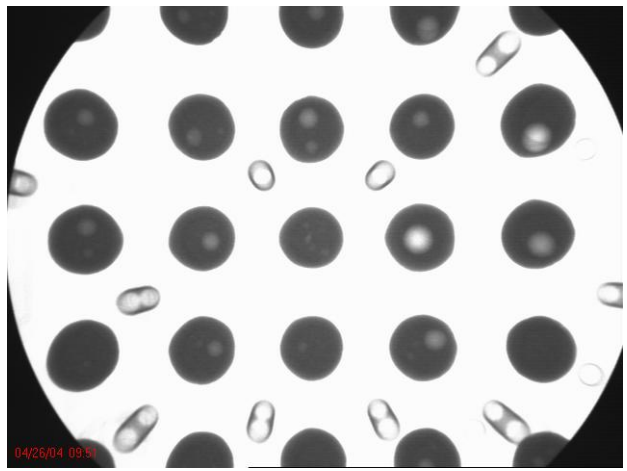
Comparison of void percent between SnAgCu and SnPb BGAs soldered with SnAgCuBi solder

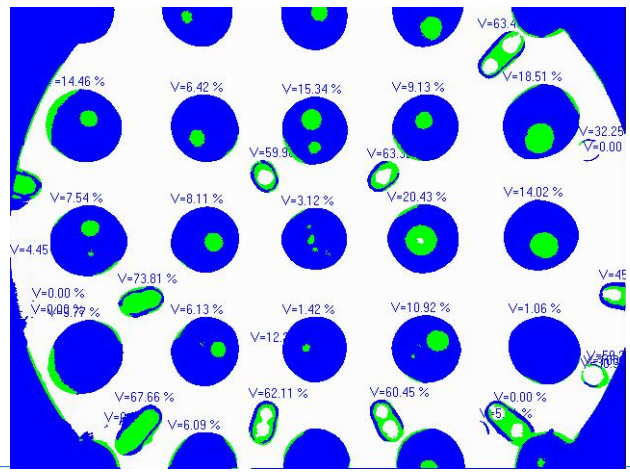
SN127 U4 SnAgCu
0.4-12 void percent





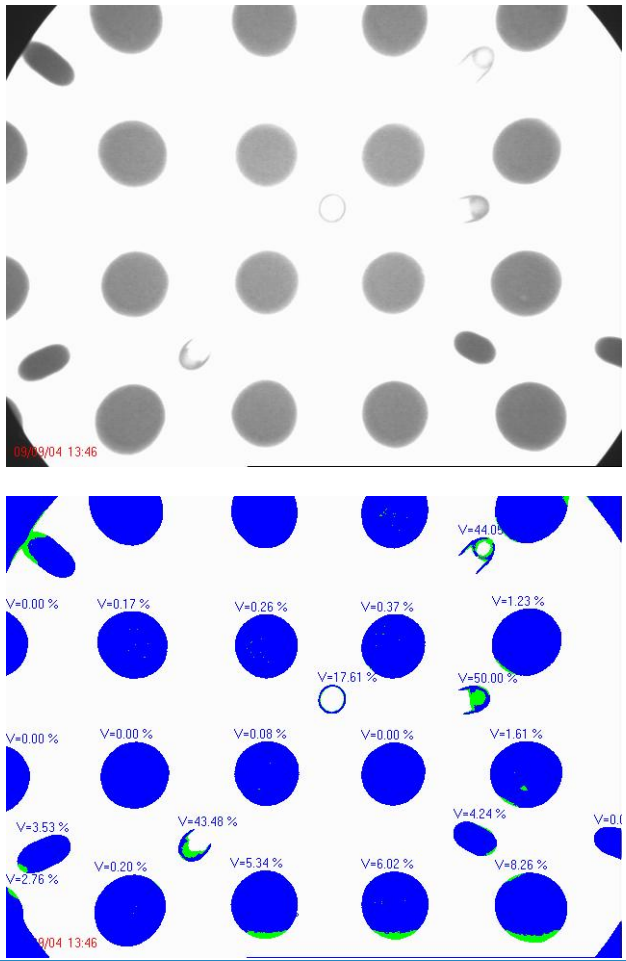
SN127 U44 SnPb
1-20 void percent



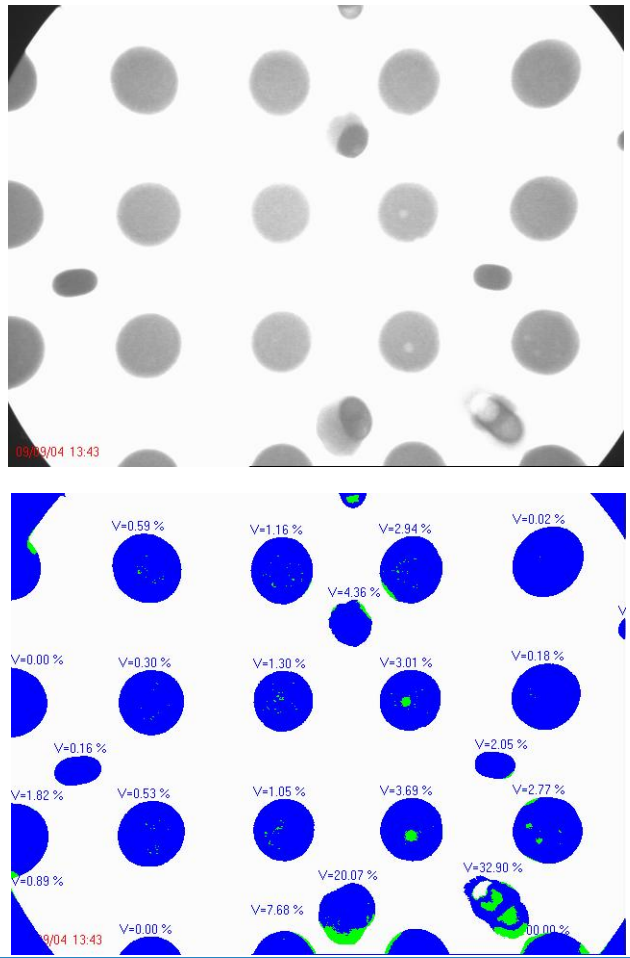


Comparison of SnAgCu BGAs replaced on SnAgCu and SnAgCuBi Rework Assemblies

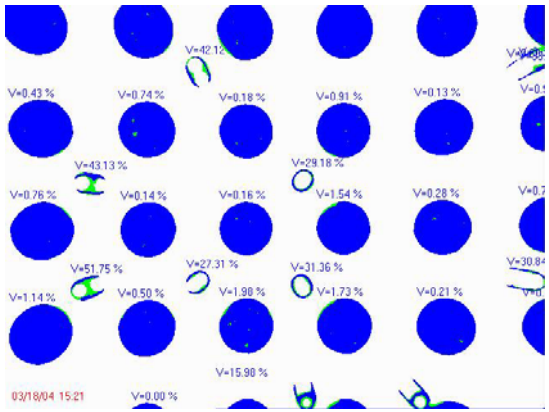
SN205 U4 reworked



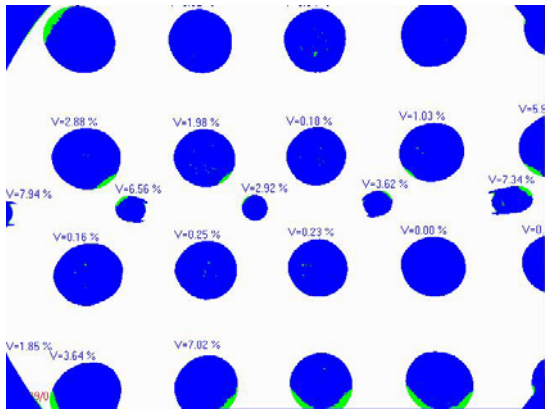
SN177 U4 reworked
0-3.69 void percent



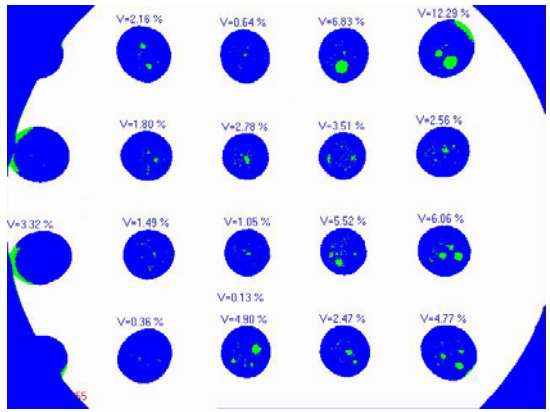
BGA and Solder Comparison



SnPb with SnPb



SN110 U55 SnAgCu with SnAgCu



SN127 U4 SnAgCu with SnAgCuBi
0.36-12.29 void percent

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Surface Insulation Resistance and Electrochemical Migration Resistance

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Surface Insulation Resistance and Electrochemical Migration Resistance Test Vehicles

SIR

- 46 IPC-B-24 boards (SIR)
- IPC-TM-650 Method 2.6.3.3
  - 6 boards with SnAgCu reflow solder alloy and flux
  - 6 boards with SnAgCuBi reflow solder alloy and flux
  - 6 boards with SnPb reflow solder alloy and flux
  - 6 boards with SnCu wave solder alloy and flux
  - 6 boards with SnAgCu wave solder alloy and flux
  - 6 boards with SnPb wave solder alloy and flux
  - 5 boards with bare copper finish, no solder paste, only processed through cleaning procedures
  - 5 Boards with bare copper finish, no solder paste, passed through reflow and wave solder machines then cleaned

EMR

- 46 IPC-B-25A boards “D-comb pattern”
- IPC-TM-650 Method 2.6.14.1

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Lessons Learned

Lessons Learned

- Components are critical!
  - XRF was used to verify the surface finish of components.
    - Incorrect surface finish (mix lot) DIPs from vendor
  - Lead-free components have different moisture sensitivity ratings.
  - Logistics: Tight control of parts was required, i.e. SnAgCu Manufactured boards required a combination of tin-lead and lead-free surface finish BGAs, TSOPs, and CLCCs (only SnAgCu lead finish).
  - Because components are not marked for lead-free solder, some components were marked to differentiate between surface finish.

Lessons Learned Continued

- Solder paste printing process does not require changes when using lead-free solder.
- Component placement process does not require changes for lead-free solder.
- Reflow as expected is the major process difference.
  - Lead-free solder's full liquidus temperature is approximately 38 degrees higher than SnPb; but the components and board thermal properties have not changed.
  - The decreased process window made thermal profiling a challenge.
    - High temperature insulation thermocouples will be necessary for future work.
  - The conveyor speed was slowed down and zone temperatures increased by 20-60°C depending on oven zone.
  - Visual examination in some cases is not a good indicator whether the reflow has been accomplished; have to rely on temperature and time.
    - Lead-free solder joints have a grainy appearance, some are not as shiny, the foot of the lead on surface mount components are more visible, and they don't wet out like SnPb.

Lessons Learned Continued

- Wave soldering with lead-free solders was also challenging.
  - Solder balls were visible every where.
  - Flux material is very critical
    - flux nozzle and fluxing parameters were changed to improve the flux function
- Rework using lead-free solder also required profile changes because of the higher temperatures required.
  - A new lead-free program (template) was required.
  - Assemblies were baked before rework.
  - Extra caution was required during thermal profiling because of the maximum temperature the components can withstand (260°C).
  - Continuity test, X-ray, and ERSA were performed on each BGA after rework.
    - It may take years before confidence level is developed
  - Site cleaning was not as easy due to the higher temperatures.

Lessons Learned Continued

- Hand soldering is similar to SnPb after practice (learning curve).
  - higher temperature (700°C) tips are required
  - flux is required especially if the solder wire doesn't contain any
  - some pads were lifted due to the higher tip temperature and because the lead-free solders do not flow as well as SnPb.

- Smaller (0.37"X 0.37") polyimide labels did not withstand LF wave soldering.

- Cleaning:
  - Due to higher temperatures used, assemblies that were reworked required additional cleaning to remove flux under BGAs prior to endoscopic inspection.

- Quality Inspection:
  - The solder joint appearance varied from baseline SnPb due to the different wetting characteristics.
  - Additional training is required and our acceptability documents must be revised.
  - Visual aids would be helpful (acceptability pictures).

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Final Comments

BAE SYSTEMS

Test		Performed By
Vibration	MIL-STD-810F, METHOD 514.5, PROCEDURE I	Boeing-Seattle
Thermal Shock	MIL-STD-810F, METHOD 503.3, PROCEDURE I	Boeing-Seattle
Thermal Cycling -55°C to +125°C	IPC-SM-785	Rockwell Collins
Thermal Cycling -20°C to +80°C	IPC-SM-785	Boeing-Seattle
Mechanical Shock Pathfinder	MIL-STD-810F, METHOD 516.5, PROCEDURE I	ACI/ BAE Systems Lansdale
Mechanical Shock Test Set I	MIL-STD-810F, METHOD 516.5, PROCEDURE I	ACI/ BAE Systems Lansdale
Mechanical Shock Test Set II	MIL-STD-810F, METHOD 516.5, PROCEDURE I	ACI/ BAE Systems Lansdale
Combined Environments Test	MIL-STD-810F, METHOD 520.2, PROCEDURE I	Raytheon
Salt Fog	MIL-STD-810F, METHOD 509.4	ACI
Humidity	MIL-STD-810F, METHOD 507.4	ACI
SIR	IPC-TM-650, METHOD 2.6.3.3	Boeing-Anaheim
EMR	IPC-TM-650, METHOD 2.6.14.1	Boeing-Anaheim
Characterization		Rockwell Collins

Acknowledgements

The following JG-PP/JCAA companies provided technical support and/or materials that made this effort possible:

- ACI – Pb-free skill training for hand soldering
- BAE Systems Irving – factory time and labor expenses
- Boeing-Seattle – technical support
- Florida CirTech, Inc. – materials
- Global Stencil – stencil services
- Heraeus – materials
- Kyzen – board cleaning after Pb-free wave solder
- MSL- translation of design data from Zuken Redac to GENCAD (Version 1.3).
- Rockwell-Collins – provided board design, procurement of components and bare boards
- Senju Solder - materials
- Vitronics-Soltec – wave solder machine for Pb-free portion of assembly

BAE SYSTEMS

Group Picture

BAE SYSTEMS

Contact Information:

ana.l.campuzano-contreras@boeing.com
or
ana.campuzano-contreras@baesystems.com

3131 Story Road
Irving, TX 75038

(972)659-2546

BAE SYSTEMS

Back Up Information

DEK 288 Solder Paste Screen Printer

Component Placement:

FUJI CP IV used for placement of capacitors and resistors.

FUJI IP3 used for fine pitch, BGAs, and other parts.

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Solder Reflow: ABW Systems TSC-1210

Cleaning: Corpane Semi Aqueous Cleaner

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Evaluation- X-Ray: Nicolet Imaging Systems 1410Hb

Hand Soldering

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Rework (Removal and Replacement)

Wave Soldering: Delta-Max Machine

Wave Soldering @ Vitronics-Soltec: Delta-Wave Machine

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BGA removal and replacement: AIR-VAC DRS24C