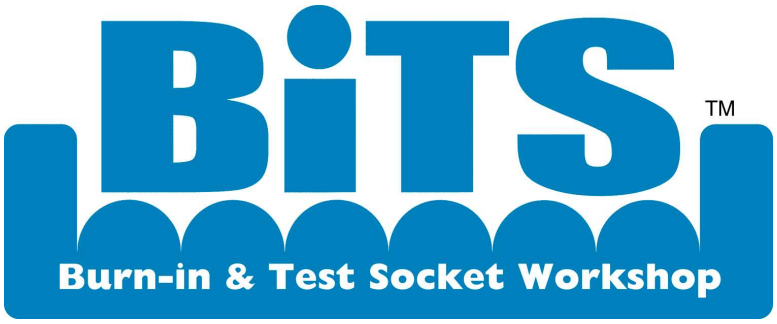


ARCHIVE 2006

Session 2

Socket Design And Performance

"Innovative Socket Technology For 0.3mm Pitch BGA Devices"
Ila Pal — Ironwood Electronics, Inc.

"Socket Performance Over Time And Insertion Count With Pb-Free Applications"
Jeff Sherry, Bert Brost — Johnstech International Corporation

"A Case For Socket Reuse – An Approach To Managing The Cost Of High-End Burn-In Sockets"
Paul Gaschké, Dave Carpentier — IBM Systems and Technology Group

Ironwood Electronics, Inc.

Innovative Socket Technology for 0.3mm Pitch BGA Devices

ILA PAL

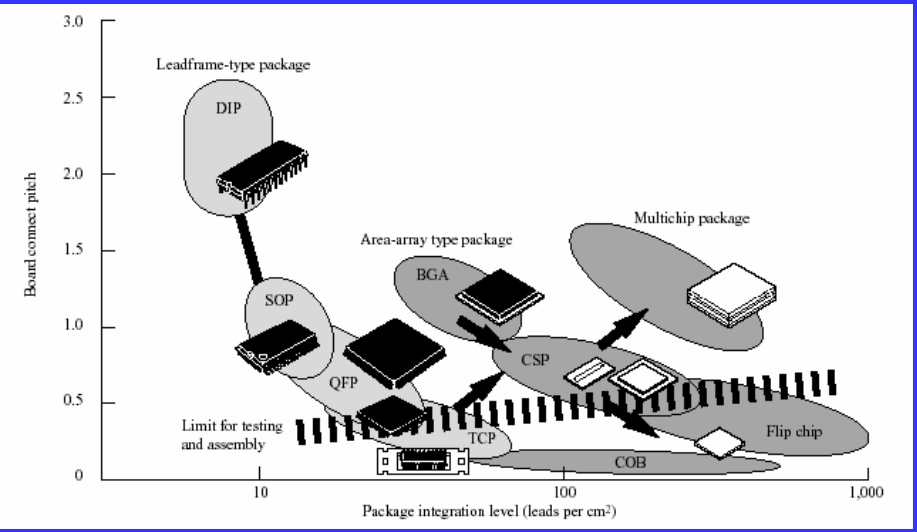
1

Agenda

- Packaging roadmap
- 0.3mm pitch BGA package
- Socket mounting background
- Socket design
- Embedded wire in elastomer
- Experiments
- Results
- Conclusions

2

Packaging Roadmap



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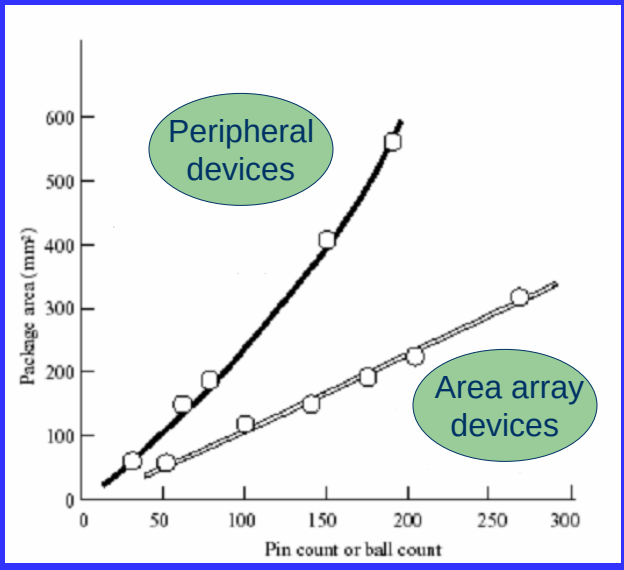
Source: Hitachi review volume 48

Packaging Roadmap



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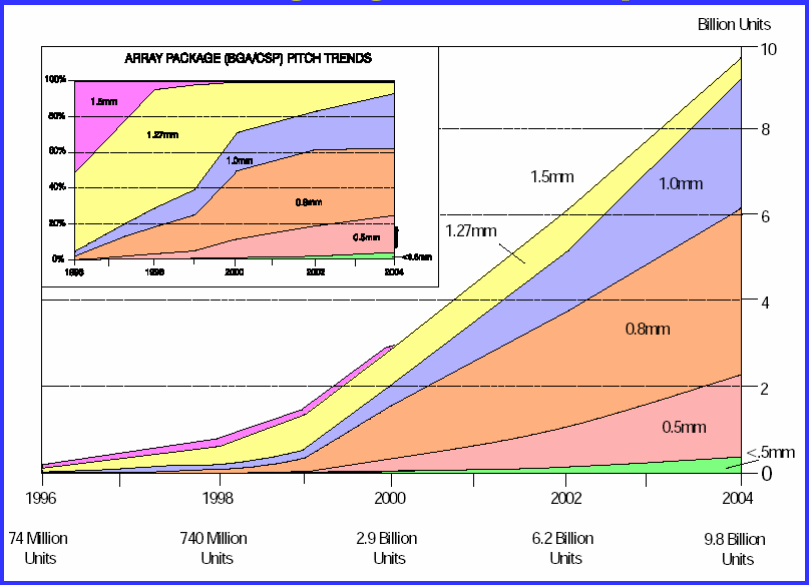
Source: Hitachi review volume 48

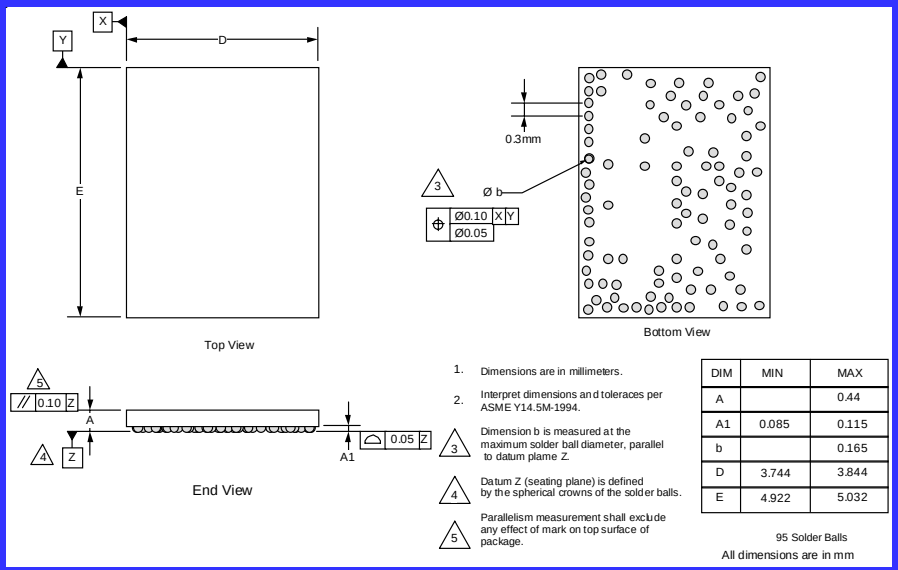
Packaging Roadmap



Source: Prismark Partners LLC

5

0.3mm Pitch BGA Package



1. Dimensions are in millimeters.
2. Interpret dimensions and toleraces per ASME Y14.5M-1994.
3. Dimension b is measured at the maximum solder ball diameter, parallel to datum plame Z.
4. Datum Z (seating plane) is defined by the spherical crowns of the solder balls.
5. Parallelism measurement shall exclude any effect of mark on top surface of package.

DIM	MIN	MAX
A		0.44
A1	0.085	0.115
b		0.165
D	3.744	3.844
E	4.922	5.032

95 Solder Balls
All dimensions are in mm

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Socket mounting background

- Fastener mount
- Solder mount
- Epoxy mount

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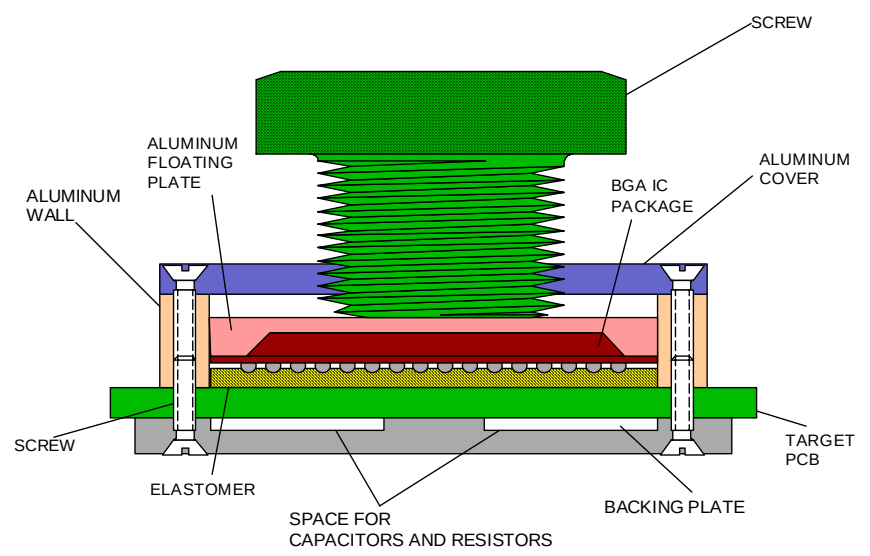
Fastener mount socket



8

Fastener mount socket

- Solder-less socket
- Easy assembly and disassembly
- No rework cost
- Backing plate provides stiffness and rigidity
- Keep-out area is still a significant % of overall package area
- Requires through holes in PC board

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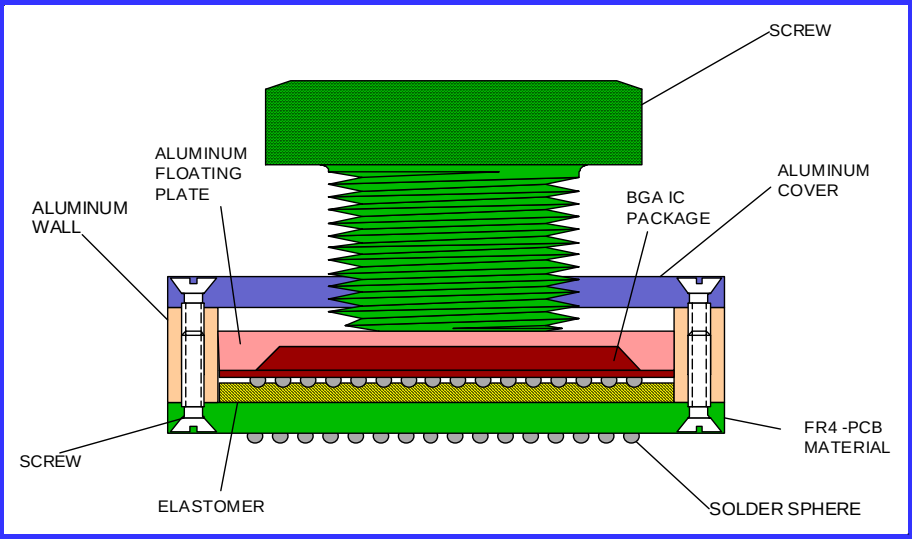
Solder mount socket



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Solder mount socket

- Assembled using standard reflow method
- Very difficult to disassemble
- More rework cost
- Target PCB has to be thicker to provide stiffness and rigidity
- Keep-out area is a large % of overall package area
- Requires no through holes in PC board

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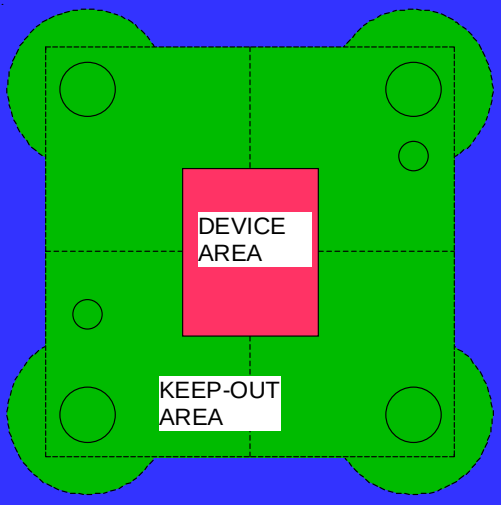
Device area and Keep-out area



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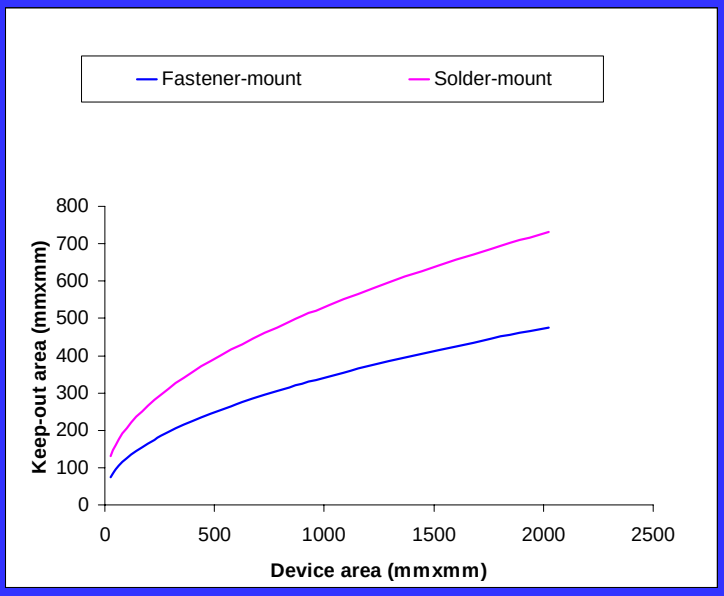
Comparison of mounting configurations



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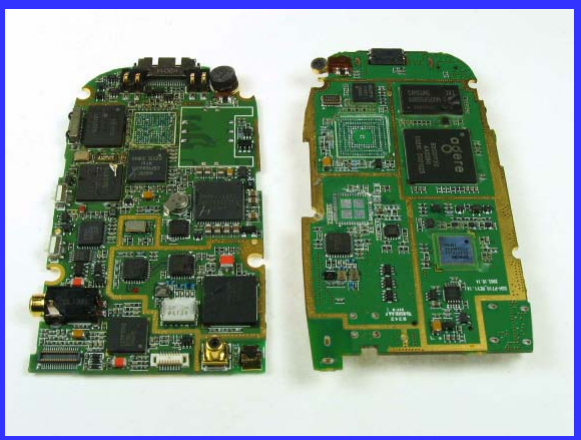
BGA devices in Cell Phones

- Signal processors
- SRAMs
- Flashs
- ASICs
- Other devices
- ……



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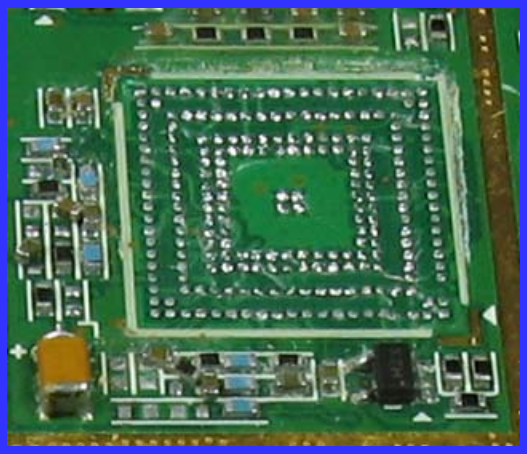
BGA devices in Cell Phones

- How much keep out area is allowed to mount a socket?



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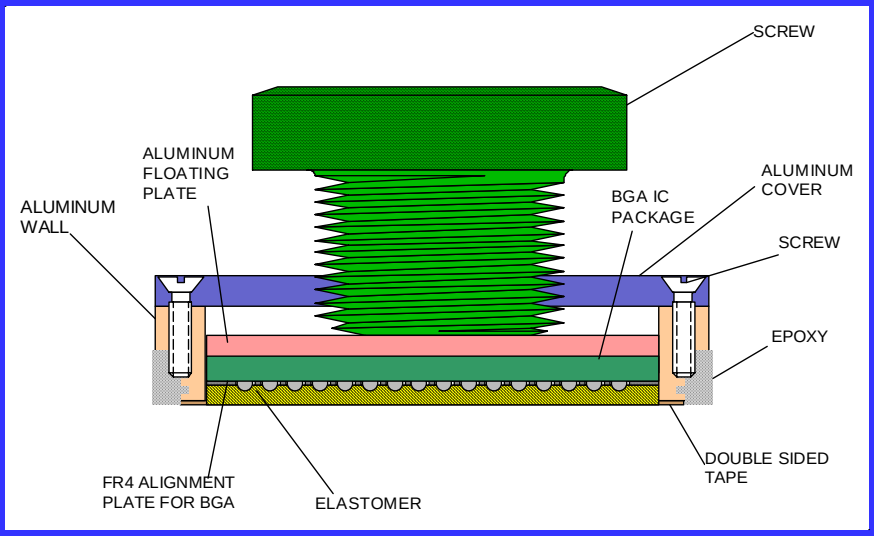
Epoxy mount socket



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Epoxy mount socket

- Requires no through holes in PC board
- Requires no soldering onto PC board
- Target PCB has to be thicker to provide stiffness and rigidity
- Keep-out area is a very minimal % of overall package area
- Very difficult to rework and disassemble

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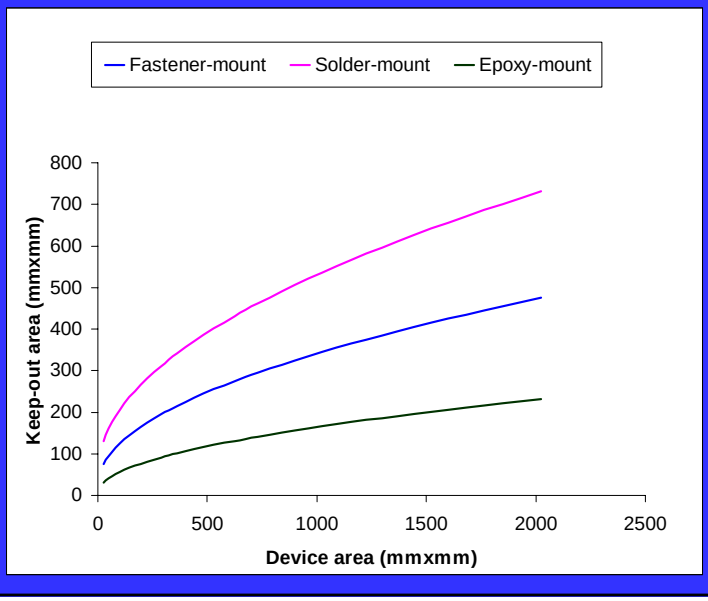
Comparison of mounting configurations



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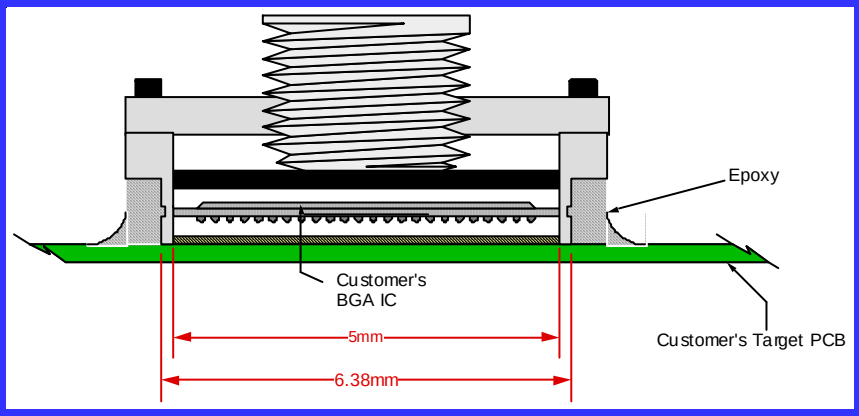
Socket Design



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US Patent 6,533,589

Socket Design

F_1 = force needed to compress the device
F_2 = epoxy retention force per square mm
F_2 = f/A
f = epoxy retention force
A = surface area

Safety design recommends:

$f = 1.5F_1$
$AF_2 = 1.5F_1$
$A = 1.5F_1/F_2$

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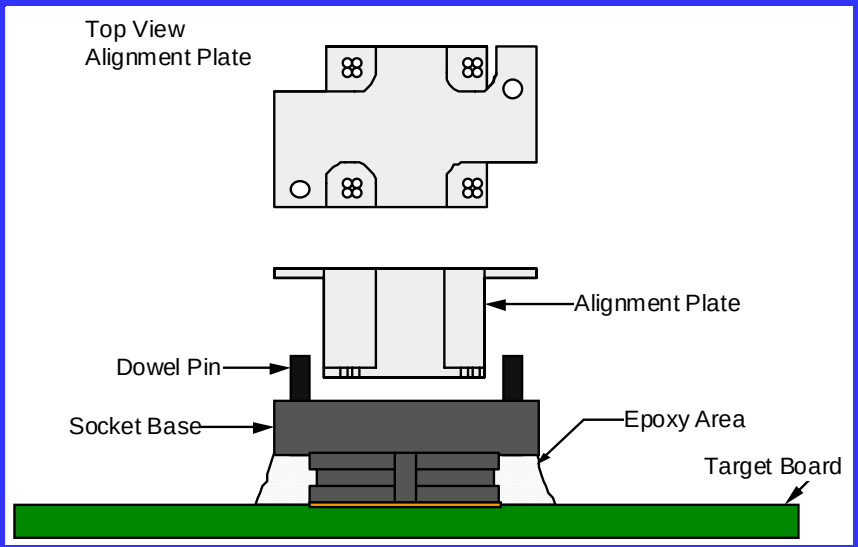
Socket Design



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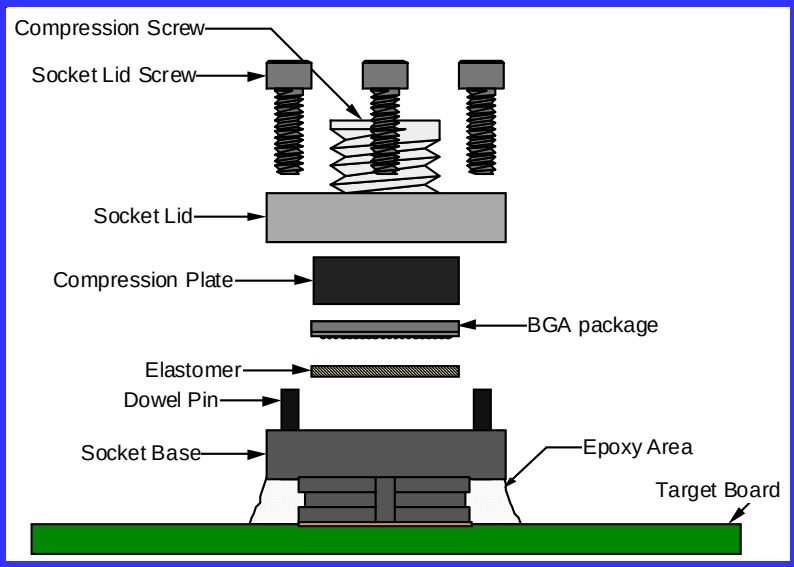
US Patent 6,533,589

Socket Design



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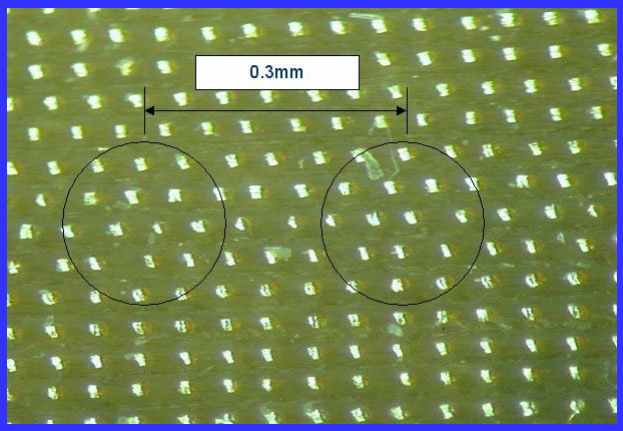
US Patent 6,533,589

Embedded wire in elastomer



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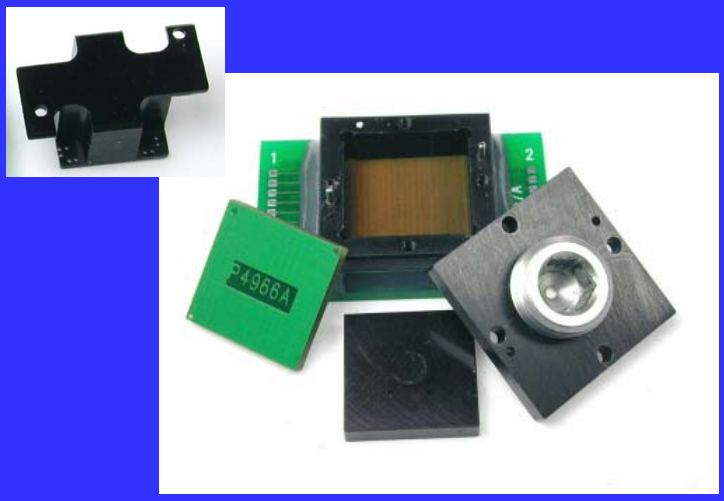
Experiment



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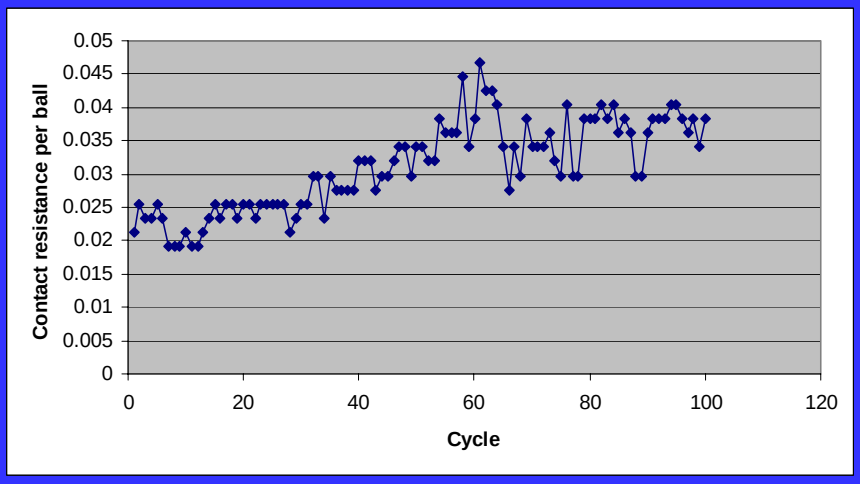
Results



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Conclusions

- Epoxy mount socket requires minimal keep out area
- Properly designed socket was epoxy mounted on many handheld PCBs for failure analysis
- Elastomer contact was successfully tested for 0.3mm pitch BGA devices
- This concept was tested on peripheral devices (QFN) also

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Thank You
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Socket Performance Over Time and Insertion Count With Pb-Free Applications

2006 Burn-in and Test Socket Workshop
March 12 - 15, 2006

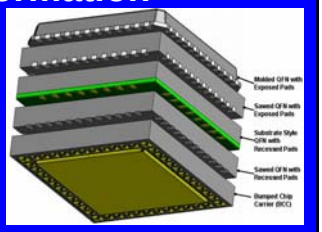
Bert Brost and Jeff Sherry
Johnstech International

Agenda

- Package I/O Plating and Composition
- SnPb Performance and Repeatability
- Pb-Free Performance Issues
- Contact Plating and Composition
- Effects of Pb-Free Device Plating
  - Matte Tin
  - NiPdAu
- Device I/O Surface Oxide Penetration and Removal
- Conclusions

Package I/O Plating and Composition

– Type of package
  • Pad vs. Leaded vs. BGA vs. Other
– Device plating effects - Oxide formation
  • Lead-based vs. Lead-free
– Effects of tolerances
– Size of pads and pitch
– Type of device being packaged
  • RF, amplifiers, digital, mixed signal
– Debris generated
  • Sawed vs. Molded vs. Broken



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Package I/O Plating and Composition

- Matte Tin (very high percentage of Pad and Leaded packages)
- NiPdAu (small percentage but growing – harder smoother surface)
- SnAgCu (mostly BGA devices – SAC305)
- SnBi (used mostly in Japan)
- Au
- Other Sn based materials
  SnCu
  SnAg
  SnNi

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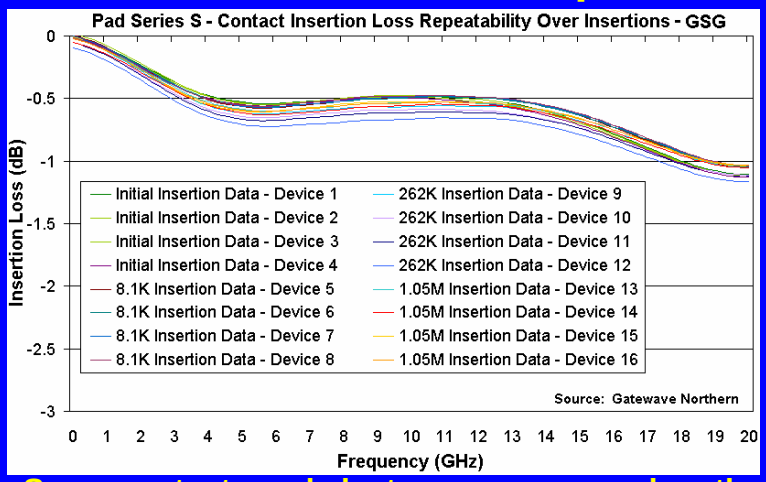
SnPb Performance and Repeatability



NOTE: Same contacts and elastomers were used on the entire test, surrogate devices replaced every 100K insertions

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Pb-Free Performance Issues

- More oxidation on leads or pads on Sn
  - More false failures
  - More contact cleaning / maintenance
  - Higher contact forces
- Different companies have different solutions – no standardization yet

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Contact Plating and Composition

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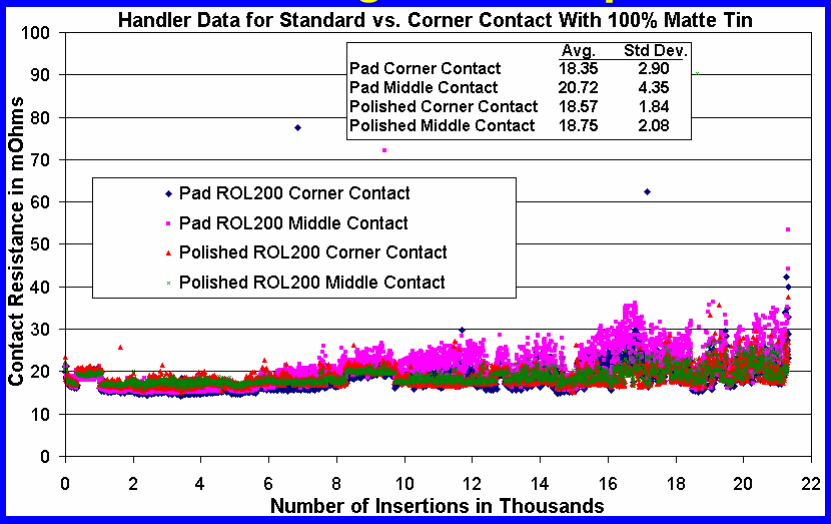
Contact Plating and Composition



Matte Tin Effect on Contact Location and Smoothness

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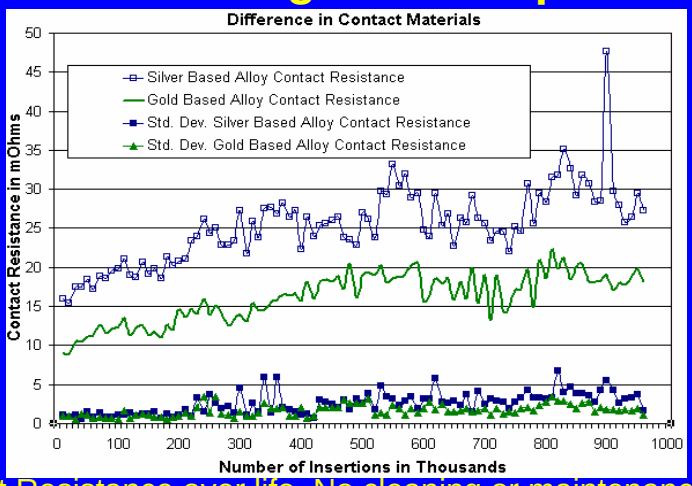
Contact Plating and Composition



Contact Resistance over life. No cleaning or maintenance with 90/10 solder plating on test vehicle

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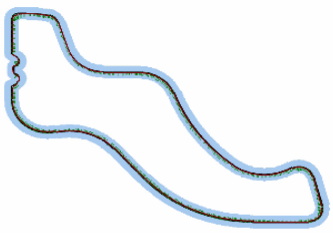
Effects of Pb-Free Device Plating – Matte Tin

SnPb - 1.6 Million insertions Matte Tin - 300K insertions

MeasureFit Report

Wear
Max Positive Deviation: +0.0001
Max Negative Deviation: -0.0118
Standard Deviation: +0.0017

Result: Pass
Fit Method: Least Squares
Features Out of Size Tolerance: 0



Wear
Max Positive Deviation: +0.0089
Max Negative Deviation: -0.0118
Standard Deviation: +0.0017

Result: Pass
Fit Method: Least Squares
Features Out of Size Tolerance: 0

Contacts not cleaned during test

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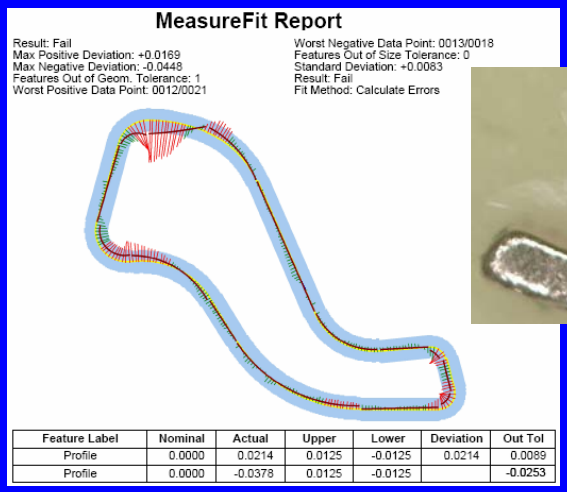
Effects of Pb-Free Device Plating – Matte Tin

Standard ROL100 Contact Profile After 1 Million Insertions



Feature Label	Nominal	Actual	Upper	Lower	Deviation	Out Tol
Profile	0.0000	0.0214	0.0125	-0.0125	0.0214	0.0089
Profile	0.0000	-0.0378	0.0125	-0.0125		-0.0253

No cleaning performed during test

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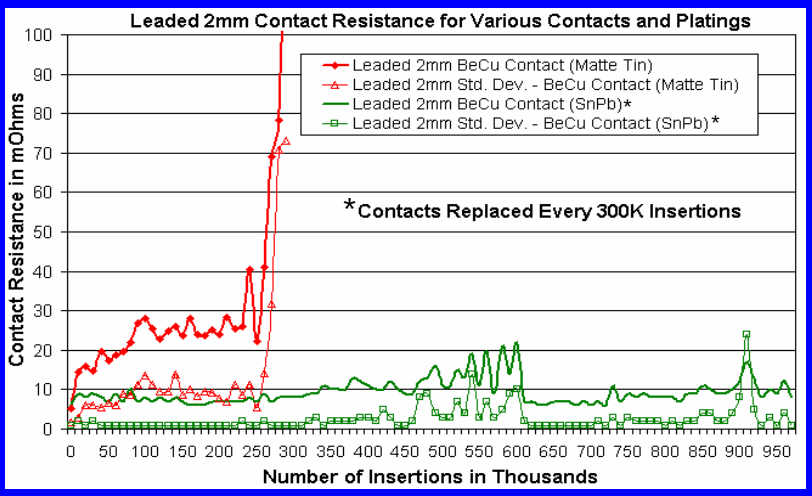
Effects of Pb-Free Device Plating – Matte Tin



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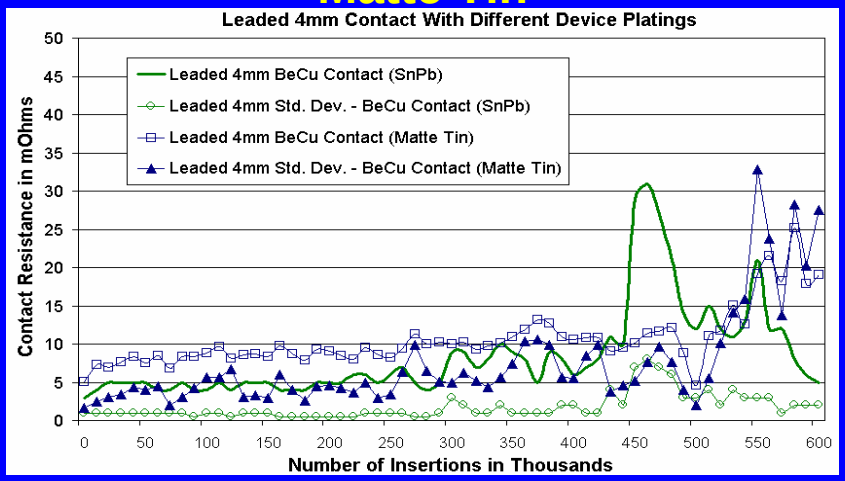
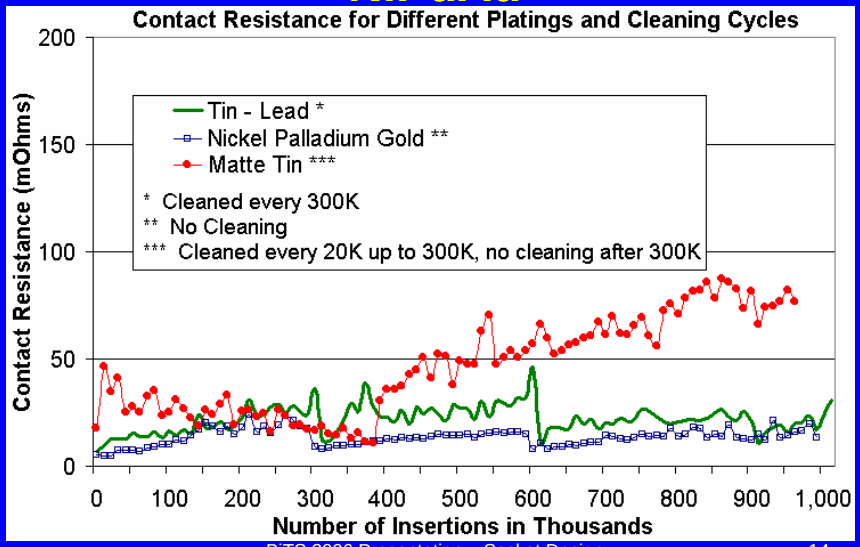
Effects of Pb-Free Device Plating – Matte Tin

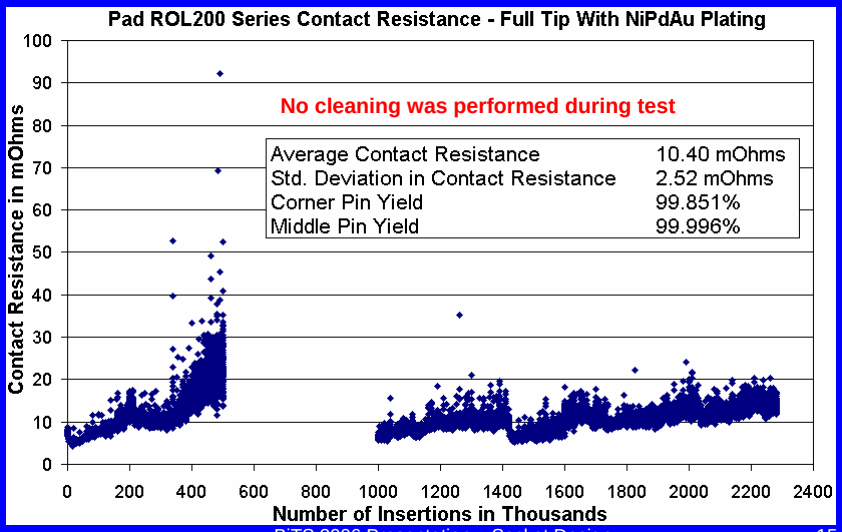


Leaded 4mm Contact Resistance - SnPb vs. Matte Tin Plating

Effects of Pb-Free Device Plating – NiPdAu



Effect of Pb-Free Device Plating – NiPdAu



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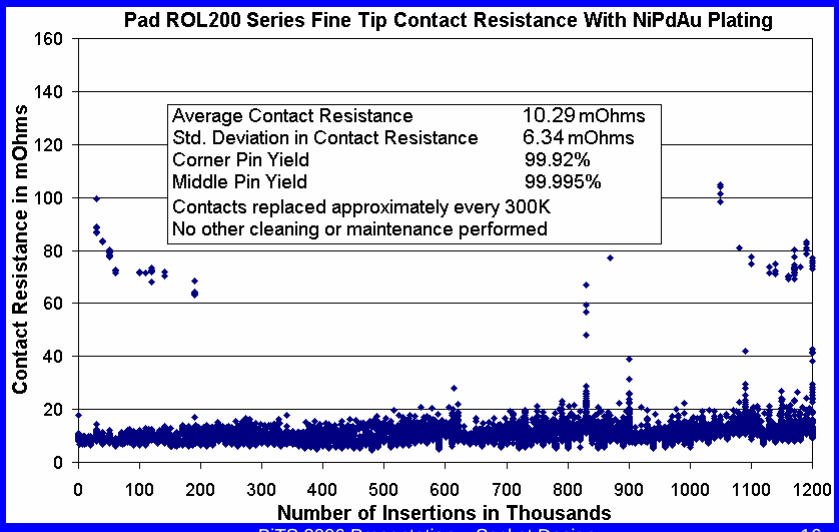
Effects of Pb-Free Device Plating – NiPdAu



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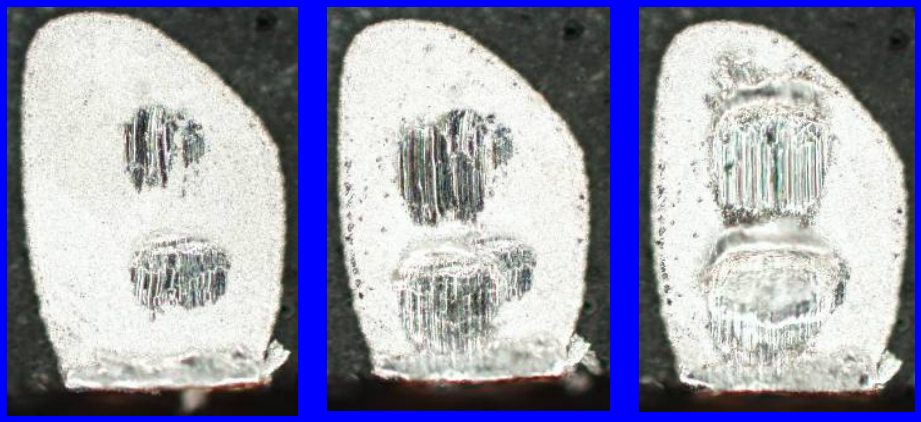
Device I/O Surface Oxide Penetration and Removal

SnPb -1 Insertion | SnPb - 10 Insertions | SnPb - 50 Insertions



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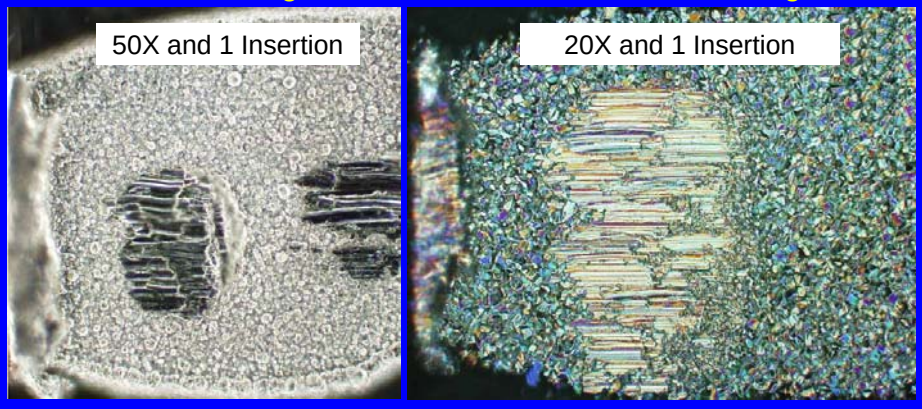
Device I/O Surface Oxide Penetration and Removal

SnPb Plating | Matte Tin Plating



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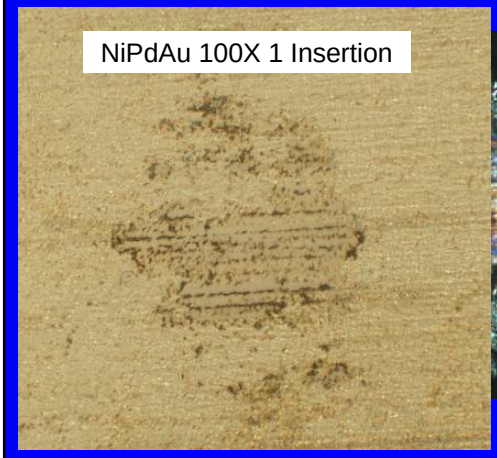
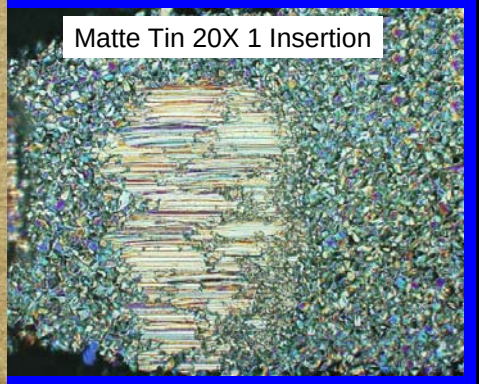
Device I/O Surface Oxide Penetration and Removal

NiPdAu 100X 1 Insertion



Matte Tin 20X 1 Insertion



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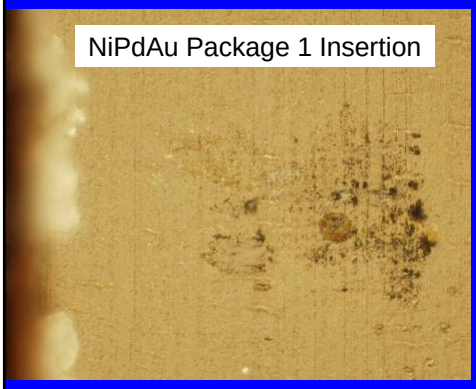
Device I/O Surface Oxide Penetration and Removal

NiPdAu Package 1 Insertion



NiPdAu Package 50 Insertions

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Conclusions

- There are many Pb-Free platings with each having different benefits
- More plating oxides generally result in more cleaning of contacts to maintain performance
- Matte Tin plating is inexpensive, but because of oxides, results in higher contact resistance and may not be the best choice for resistance sensitive devices
- Harder plating results in lower contact life
- Some Pb-Free platings require more force to break through oxides
- Self cleaning wipe function is critical to long-term Pb-free performance

BiTS 2006 Presentation – Socket Design 21

A Case for Socket Reuse

An Approach to Managing the Cost of
High-End Burn-In Sockets

Burn-in and Test Socket Workshop
March 12 - 15, 2006

Paul Gaschké
Dave Carpentier
IBM

Agenda

An Approach to Managing the Cost of
High-End Burn-In Sockets

- **What Drives the Cost?**
- **What Can be Done to Manage the Cost?**
- **A Flexible Socket Design is a Must**

What Drives the Cost?

- High current contacts
  - 4+ amp continuous per pin 1mm clustered
    - Sympathetic heating from adjacent contacts
  - Low and stable contact resistance
- High contact count
  - 1,000 to 2,000 per socket

BiTS 2006 A Case for Socket Reuse 3

What Drives the Cost?

- High clamping force
  - To compress 1,000 to 2,000 contact populations
  - Lead free BGA
    - High psi to make reliable contact
- Thermal Management
  - Integrated heat sinks
  - Integrated heaters
  - Thermal feedback

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What Drives the Cost?

- Large product sizes
  - 45mm+
  - Molding large arrays is more difficult
    - May drive more machined parts
  - Larger tolerances
- Supply and demand
  - Limited solutions can drive up cost

BiTS 2006 A Case for Socket Reuse 5

What Can be Done to Manage the Cost?
Socket Reuse

- Cost of ownership
  - A simple calculation of the cost over time
  - Each reuse would include a reconfiguration cost

Cost of Sockets

Initial use	1st reuse	2nd reuse	3rd reuse	4th reuse
100%	50%	33%	25%	20%
	50%	33%	25%	20%
		33%	25%	20%
			25%	20%
				20%

BiTS 2006 A Case for Socket Reuse 6

What Can be Done to Manage the Cost?
Socket Reuse

- Compression mount
  - Key technology
    - A must for socket reuse
  - Improved board and tester utilization
    - 100% functional sockets per board
    - Possible reduction of testers and boards
  - Serviceability
    - Failed socket positions can quickly be repaired
    - Sockets have better probability of being repaired

BiTS 2006 A Case for Socket Reuse 7

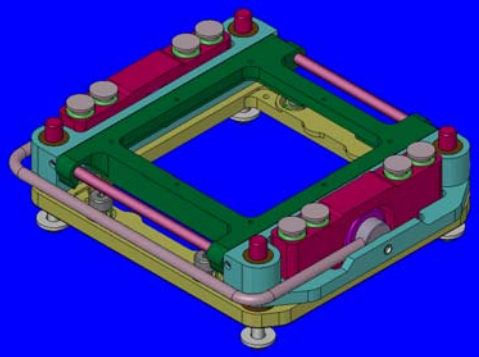
What Can be Done to Manage the Cost?
Socket Reuse

- Other considerations
  - Quick socket configurations can enable early or specialized test which can be a business advantage
  - Common hardware
    - More inventory may enable economies of scale
    - Socket cost can amortized over many years

BiTS 2006 A Case for Socket Reuse 8

A Flexible Socket Design is a Must
An Example of a Design Approach

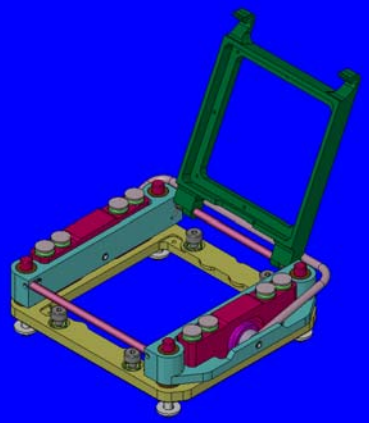
- Two part design
  - Contactor
  - Clamp
    - Patent 5,748,007



BiTS 2006 A Case for Socket Reuse 9

Clamp Sub-Assembly
A Flexible Socket Design is a Must

- Ability to adapt to product height variations
  - Thickness
    - Tolerance
  - Materials
    - Ceramic
    - Organic
  - Topography
    - Chip
    - Capacitors
    - Lids



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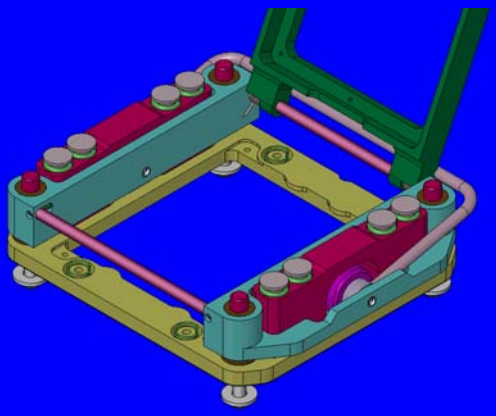
Alignment and Centering Plates
A Flexible Socket Design is a Must

- Ability to adapt to product alignment variations
  - LGA / BGA
    - Nest
    - Corner
    - Center



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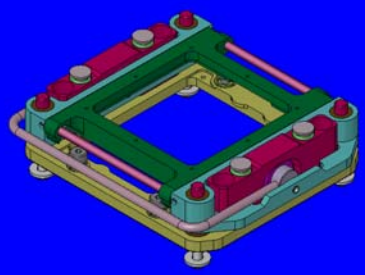
Alignment and Centering Plates
A Flexible Socket Design is a Must

- Ability to adapt to varying compression forces
  - Contacts
    - Quantity
    - Force
  - Springs
    - Quantity
    - Force



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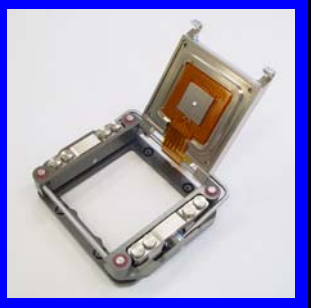
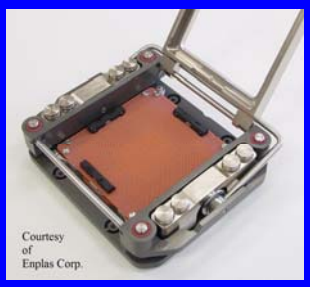
Clamp Sub-Assembly
A Flexible Socket Design is a Must

- Accommodate thermal management features
  - Open top
    - Convective
  - Heat sinks
    - Passive
    - Active
    - External



Clamp Sub-Assembly
A Flexible Socket Design is a Must

- Ability to accommodate various contactor sub-assemblies
  - Adapt to LGA, BGA, lead free, etc.
  - Adapt to varying pitch and count
  - Adapt to different electrical performance requirements



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Contactor Sub-Assembly
A Flexible Socket Design is a Must

- Ability to reuse contacts
  - Some high power contacts are very expensive
    - Reuse is virtually a must.
  - Can be the primary cost driver
- Ability to re-populate custom arrays
  - Reuse contactor housing
  - Ease of loading is a plus
  - On site maintenance and repair is a plus

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Contactor Sub-Assembly
A Flexible Socket Design is a Must

- Test both BGA and LGA with same contact?
  - A plus for expensive contacts
- Ability to contact even, odd, and mixed arrays
  - Common housing design

Last Consideration

- Managing socket reuse overhead
  - Configuration, repair, quality control, etc.
    - User managed
      - Significant training
      - Significant inventory/document management
      - Test equipment
    - Vendor managed
      - User need only enough spares to maintain 100% utilization
      - Minimal user training and inventory management
      - No test equipment

In Closing

- Demanding test specifications have increased socket costs
- Reuse can manage these costs
- A highly configurable socket design enables an efficient reuse strategy

Questions