BiTS Burn-in & Test Socket Workshop 2010

Session 6

ARCHIVE 2010

TEST AND BURN-IN OPERATIONAL CONSIDERATIONS

Test Flow and Handling of WLCSP Devices Have Significant Impact on Cost

Bob Jemison—RJI Technical Sales

Your Requirements Please!

Hideyuki Takahashi—Sensata Technologies Japan
Hide Furukawa—Sensata Technologies Inc.

Socket Cleaning With Laser

Dr. J. M. Lee, J.S. Choi—IMT Ltd.
S. K. Park—OKins Electronics, Co. Ltd.

An Environmentally Responsible Test During Burn-In System Design

Bill Barraclough, Don Richmond—Aehr Test Systems

Test Flow and Handling of WLCSP Devices Have Significant Impact on Cost

Bob Jemison, RJI Technical Sales

2010 BiTS Workshop
March 7-10, 2010

Our Challenge Today

" What can I do to lower the cost of testing my company's WLCSP product? "

WLCSP is here!

Our Employers Demand

- *Meet increasing production volumes*
- *Limit capital purchases*
- *Lower the cost of test*
- *Do more with less*

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This Presentation

Will examine a possible transition that can be made in today's test flow to increase effectiveness while lowering the cost of test

Will compare the "traditional" test flow with this new flow for WLCSP

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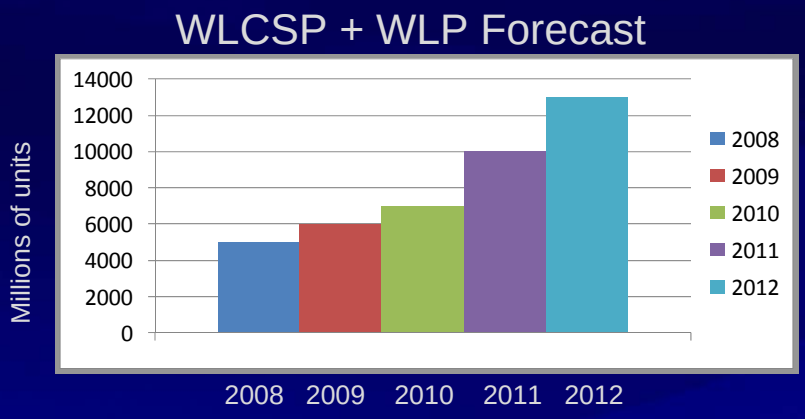
WLCSP Growth



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Restating Our Challenge

Consider the cost of test

- Management needs to lower costs
- Test is a complex combination of things
- Costs are made up of many factors
- Some are built on tradition

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Tradition Plays a Role
Simplified test flow for packaged product
Wafers-Material
Wafer Probe
• ATE
• Device Interface
• Probe Cards
• Probe Stations
Assembly
• Wafer Saw
• Sort
• Die attach
• Wire Bond
• Encapsulation
• Trim & Form
Final Test
• ATE
• Test Boards
• Test Sockets
• Device Handlers
• Marking
• Inspection
Finished Goods
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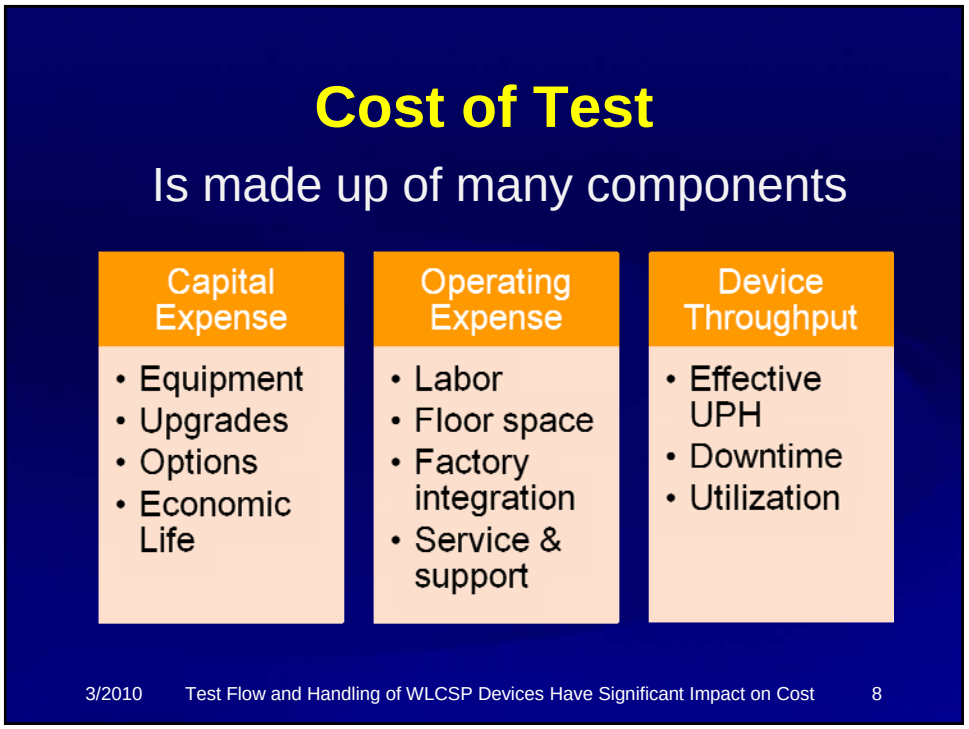
Cost of Test
Is made up of many components
Capital Expense
• Equipment
• Upgrades
• Options
• Economic Life
Operating Expense
• Labor
• Floor space
• Factory integration
• Service & support
Device Throughput
• Effective UPH
• Downtime
• Utilization
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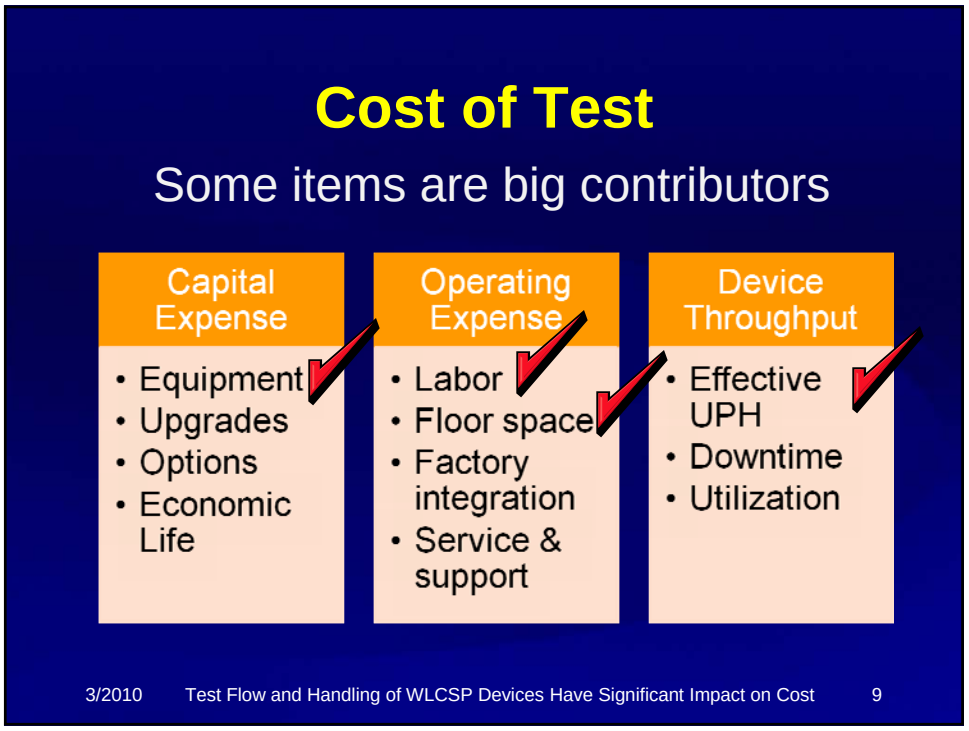
Cost of Test
Some items are big contributors
Capital Expense
• Equipment
• Upgrades
• Options
• Economic Life
Operating Expense
• Labor
• Floor space
• Factory integration
• Service & support
Device Throughput
• Effective UPH
• Downtime
• Utilization
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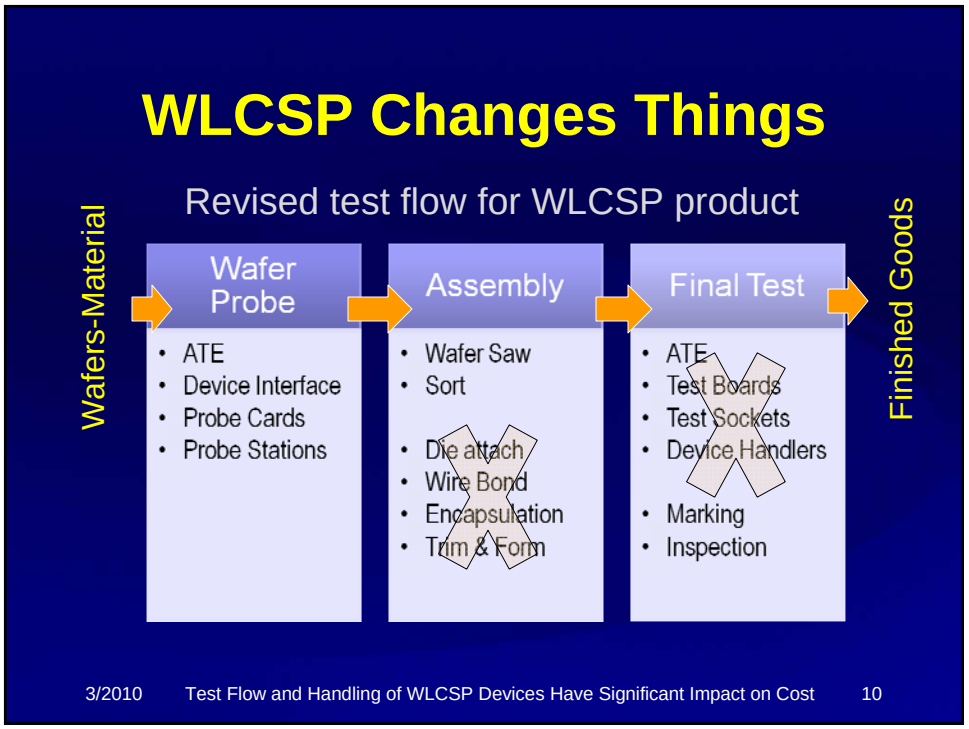
WLCSP Changes Things
Revised test flow for WLCSP product
Wafers-Material
Wafer Probe
• ATE
• Device Interface
• Probe Cards
• Probe Stations
Assembly
• Wafer Saw
• Sort
• Die attach
• Wire Bond
• Encapsulation
• Trim & Form
Final Test
• ATE
• Test Boards
• Test Sockets
• Device Handlers
• Marking
• Inspection
Finished Goods
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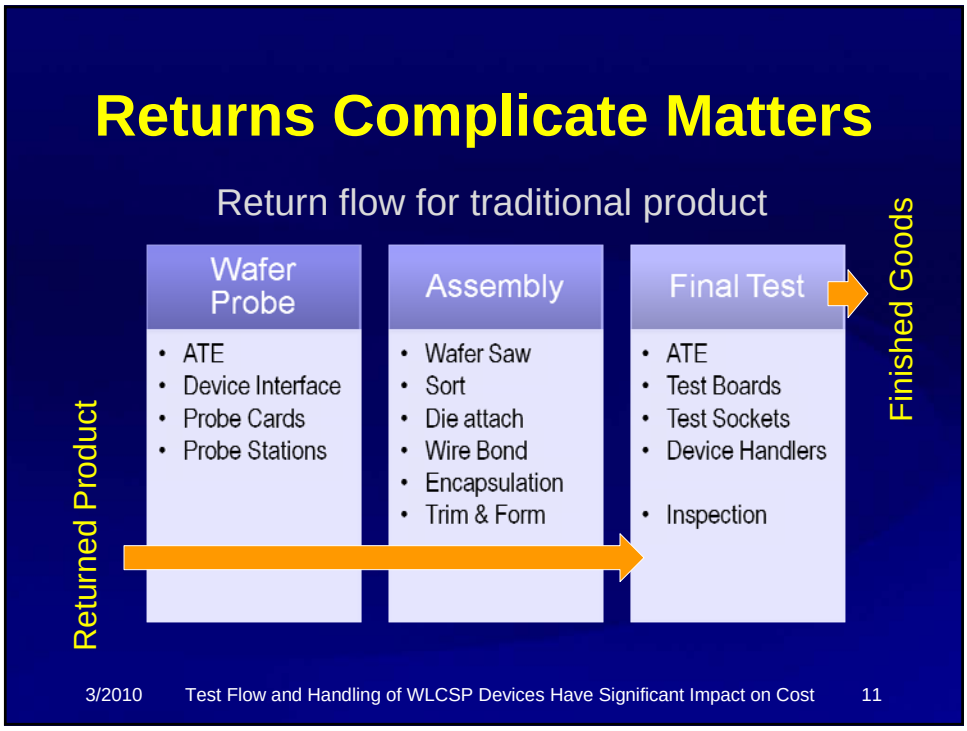
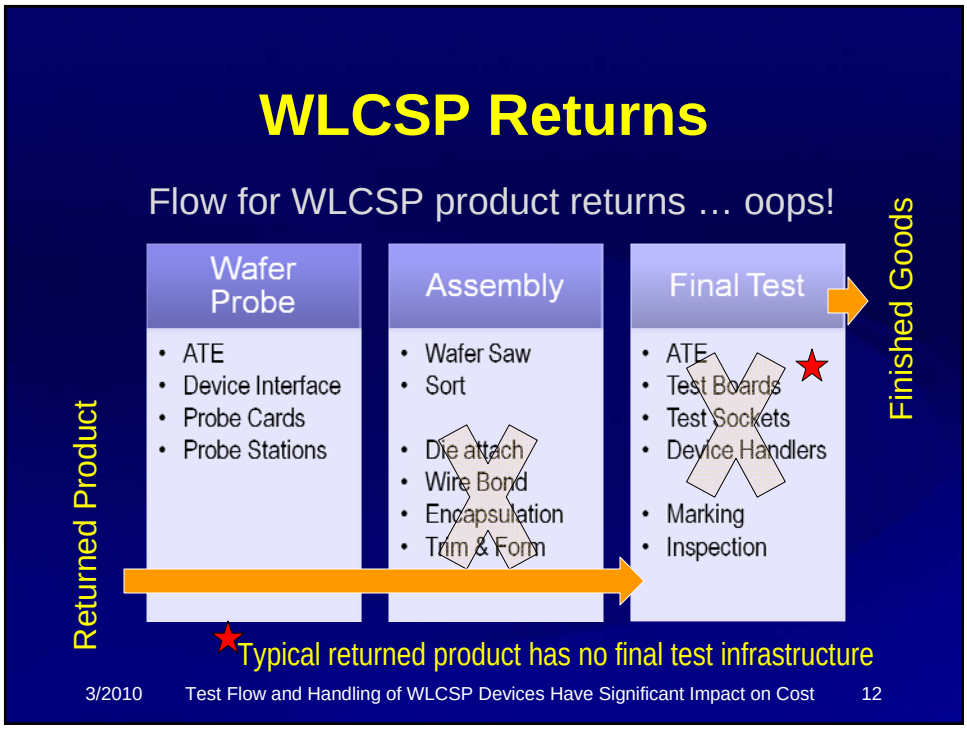

Returns Complicate Matters
Return flow for traditional product
Wafer Probe
• ATE
• Device Interface
• Probe Cards
• Probe Stations
Assembly
• Wafer Saw
• Sort
• Die attach
• Wire Bond
• Encapsulation
• Trim & Form
Final Test
• ATE
• Test Boards
• Test Sockets
• Device Handlers
• Inspection
Returned Product
Finished Goods
3/2010 Test Flow and Handling of WLCSP Devices Have Significant Impact on Cost 11


WLCSP Returns
Flow for WLCSP product returns … oops!
Wafer Probe
• ATE
• Device Interface
• Probe Cards
• Probe Stations
Assembly
• Wafer Saw
• Sort
• Die attach
• Wire Bond
• Encapsulation
• Trim & Form
Final Test
• ATE
• Test Boards
• Test Sockets
• Device Handlers
• Marking
• Inspection
Returned Product
Finished Goods
Typical returned product has no final test infrastructure
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What Have We Learned

If we want to cut costs we need to …

- Reduce the equipment needed for test
- Shrink the size to save floor space
- Reduce the number of operators needed
- Accommodate the parts flows that are required for these new WLCSP products

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WLCSP Approach

Redefine the equipment

Input Options	Tester & Interface	Inspection	Output Options
• Trays • Tubes • Wafer Frame • De-tape	• Direct dock to tester platforms • Allow probe card use or test contactors	• 6-way vision inspection • Marking	• Trays • Tubes • Tape & Reel

Combine all of these functions into one single platform

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Financial Justification

Consideration	Traditional	New Process
Capital Equip	3 – 6 Machines	1 machine
Work Flow	3 - 6 Steps	1 combined step
JIT Benefits	Multi-step process Long cycle time High cost of inventory Traceability burden	Simplified process Shorter cycle time Low cost of inventory Single station
Staffing	Multi-machines to train	Single machine to train
Returns Processing	Complicated non-std	Simple de-tape to tape
Qual/Engineering	Complicated non-std	Simple tray to tray
Development Tasks	Non-correlated	Correlates to production

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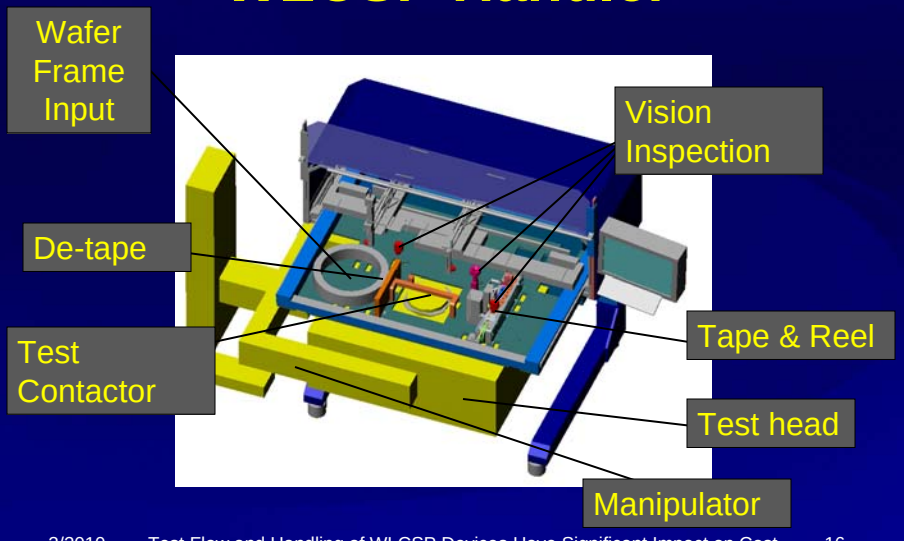
WLCSP Handler



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Typical Multipurpose WLCSP Handler

An example of a multipurpose WLCSP test handler

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Cost of Test

So, based on this information …

New equipment
Effective use of space
Fewer staff
Effective UPH

=

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In Conclusion

- New methods result in viable manufacturing
- New equipment is available in the marketplace
- Processes can be revamped today
- Improvements will result in cost savings

Acknowledgements

Contributors include:

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Your Requirements Please!

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2010 BiTS Workshop
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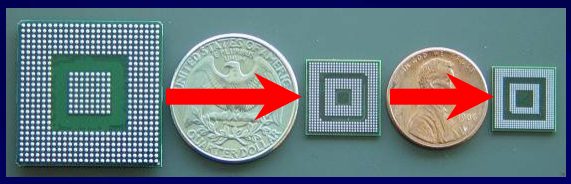
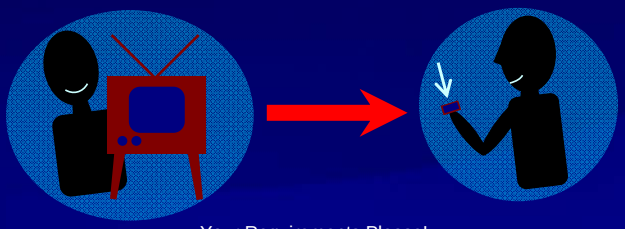
Overview

- IC package Trend
- Design requirement for a Burn In Test Socket
- Definition of Life cycle
- Mechanical life analysis
- Application Test Result
- Specification
- Conclusion

IC Package Trend

IC package becomes smaller and thinner with technology change….





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Design Requirement for a Burn In Test Socket

Components need to be changed due to…

Contact → Smaller for narrower pitch

Over all dimension → Smaller for BIB density

Mechanical part → Stronger for High force (High I/O)

All parts → Simpler & Smaller for Lower cost

All parts → Etc. etc. etc.....

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Definition of Life of Burn In Socket

- Mechanical Life
  - Contact cycle Life
  - Other parts cycle Life
- Electrical Life
  - Resistance increasing
  - Non continuity
- Design Life
  - IC matching
  - Preference

Mechanical Life Analysis (1)

Why Components break?

$$Stress = Force / Area$$

If a Force is applied to some Area and exceeds the Limit of a Material, Components start to fail.

To avoid the failure,

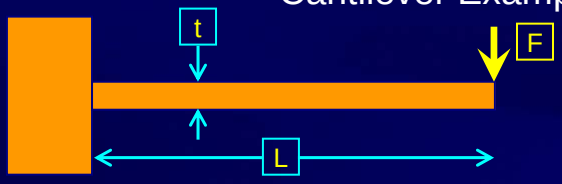
Make the Force lower, or

Make the Part larger, or

Make the Part with Stronger Material

Mechanical Life Analysis (2)

Cantilever Example



B = Width (depth direction)

$$Stress = (6FL) / (Bt^2)$$

Stress is proportional to Force and Length,

Stress is inversely proportional to Width and square of Thickness.

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Mechanical Life Analysis (3)

To Keep Stress same Level?

To avoid failure while keeping Stress at the same Level,

Force lower	→	Effect on performance?
Part larger	→	Bigger Socket?
Stronger Material	→	Price Up?

Totally Opposite to Customer request !!

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Mechanical Life Analysis (4)

Socket Cycling Test overview

Actuate Sockets with Varied Stress Level

- Cycle test on Pinch style Contact Socket
- Apply more stress with adjusting Socket stroke
- Count Broken Contact at every 1K actuation
- Analyze 0.1% and 90% breaking cycle with a Weibull plot

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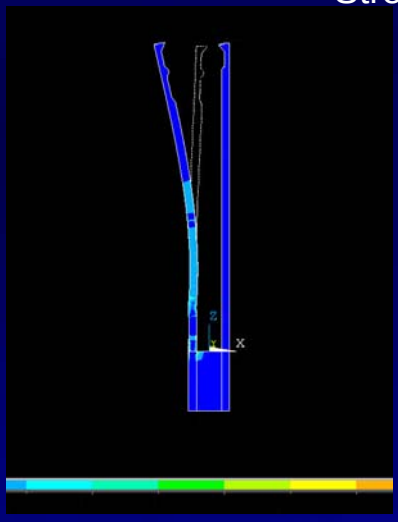
Mechanical Life Analysis (5)

Stress Analysis



$$Stress = (6FL) / (Bt^2)$$

FEA Software is a useful tool, but Hand calculation also works well at early design stage.

Either case correct boundary condition is important.

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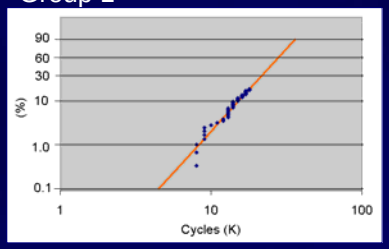
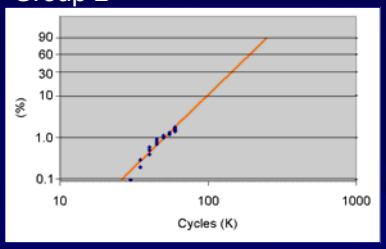
Mechanical Life Analysis (6)

Weibull Plot (1)

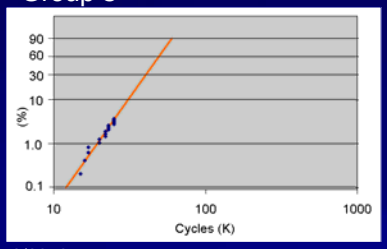
Group 1



Group 2



Group 3



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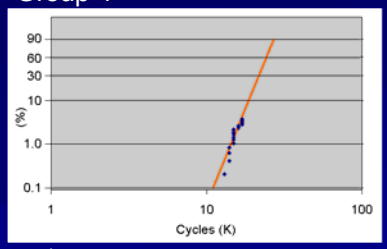

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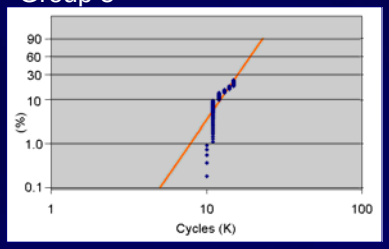
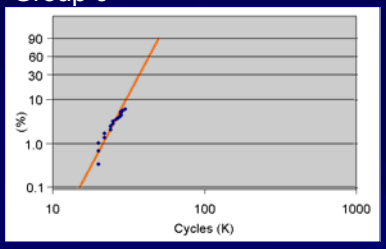
Mechanical Life Analysis (7)

Weibull Plot (2)

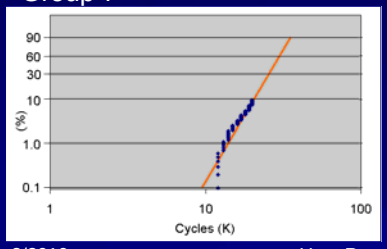
Group 5



Group 6



Group 7



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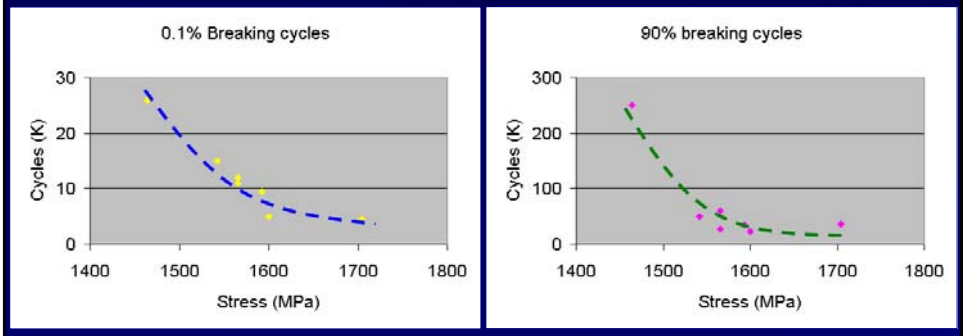
Mechanical Life Analysis (8)

Stress vs. Cycles Plot



It Seems there is a correlation between the Weibull Plot Analysis result and Contact Stress Level

Application Test Result (1)

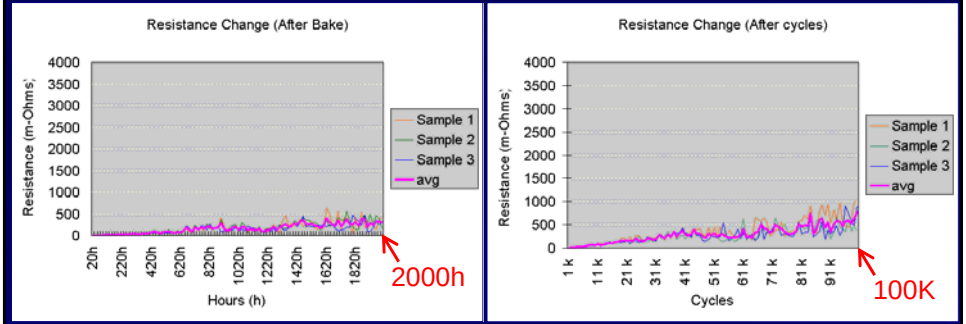
Test Overview

Baking + Cycling combination Test

- Buckling Beam type Burn In Socket (n=3)
- 0.50mm pitch IC Pb Free type (n=609)
- Bake = 135 deg.C / 20h x 100 = 2,000 h
- Cycle = 1000 cycles x 100 = 100,000 cycles
- Resistance check after Baking & Cycling

Application Test Result (2)

Test Result

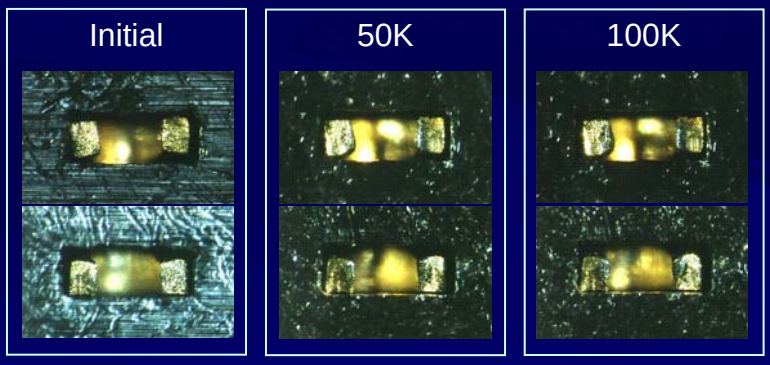


3 Sockets were OK for 2K hours Baking + 100Kcycles

Resistance increasing is 1000 m-Ohms / 2 pins

Application Test Result (3)

Contact Photos

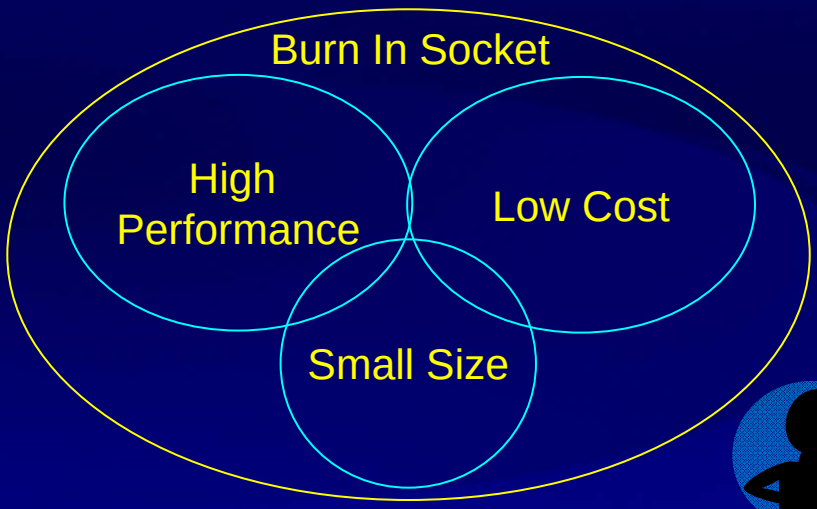


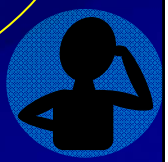
No Contact Breaking with 100K cycling

Not much Solder accumulation

Specification (1)

Design Goal of Burn In Socket





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Specification (2)

Typical Mechanical Cycle Life Specification

Burn In Socket Mechanical Cycle Life = 20K (10K IC) cycles

This is very typical specification…… but,

If Burn In cycle is 1 cycles / day,

10K cycles = 10K days = 27 years !

Even if Burn In cycles is 3 cycles / day,

10K cycles = 3.3K days = 9 years !!

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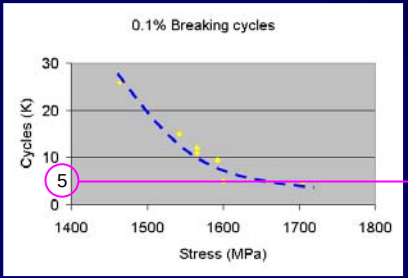
Specification (3)

Possible to Change Specification?



For example:

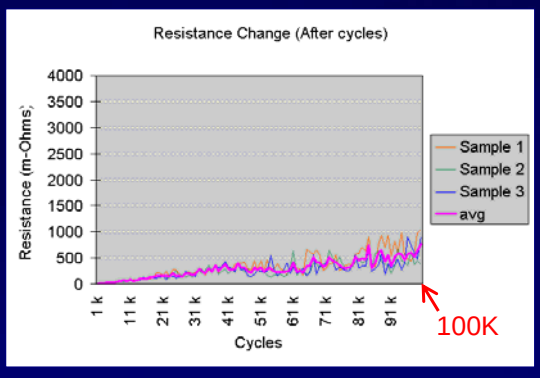
May be able to push the Socket design toward the Limit of Part Strength….

5K cycles = 2.5K IC cycles

2.5K cycles = 833 days = 2+ years (3 cycles / day)

Specification (4)

Another New Opportunity?



For example:

May be able to provide a Socket Beyond the Burn In Socket area….

Conclusion

- New Requirements Need to Be Defined
- New Requirements Need to Be Tested
- New Solutions Can Be Provided
- More Value Can Be Mined

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Socket Cleaning with Laser

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Okins Electronics Co. Ltd

2010 BiTS Workshop
March 7 - 10, 2010

Contents

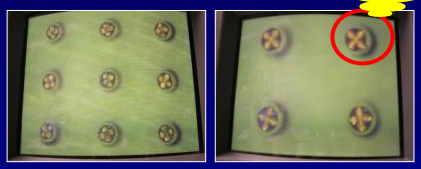
- Socket cleaning issues
- Conventional cleaning & problems
- IMT Laser cleaning technique
- Advantages of laser cleaning
- Results of laser cleaning
- Laser cleaning impacts
- Laser cleaning systems
- Conclusions
- Others: BIB socket. Probe card cleaning

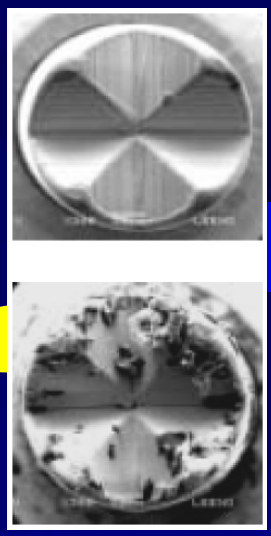
3/2010 Socket Cleaning with Laser 2

Paper #3

Test Socket Cleaning: Issue 1

- Importance of Socket cleaning
- During IC package testing, the contact pin surface is contaminated.
- Test yield decreases and system downtime increases by poor contact between package and socket pin.
- Accordingly periodic and in-situ socket cleaning is required for yield control.





*Cres, new: <80mΩ

Test Yield decreases

**Cres, after 100K contacts: >1Ω

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Tester Socket Cleaning: Issue 2

- **Leadframe Material Change**
  : Leaded => Lead free leadframe
- **Leaded leadframe: Soft (SnPb)**
- **Lead free leadframe: Hard (Sn, NiPdAu)**

***** Pin contact cleanliness and sharpness become more important for lead free package test.**

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Tester Socket Cleaning: Issue 3

- **Low & High Temperature Test**
- ➢ **High Temperature : Soft ball contact => more pin contamination**
- ➢ **Low Temperature : Hard ball contact => cleaner & sharper pin contact required.**

***** Pin surface cleaning becomes more important at high & low temp test.**

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Conventional Cleaning & Problems

>> Conventional cleaning methods

1. Manual brush cleaning
2. Chemical wet cleaning

- **Problems**
  - > Pulling sockets out of the board: additional labor
  - > Brush cleaning
    - - may cause pin surface wear
    - - is not too effective
  - > Long cleaning time => Long tester downtime
  - > Chemical wet cleaning
    - - Consumable cost & chemical waste
    - - Not suitable for emergency cleaning needs
  - > Socket reinserting process required after cleaning

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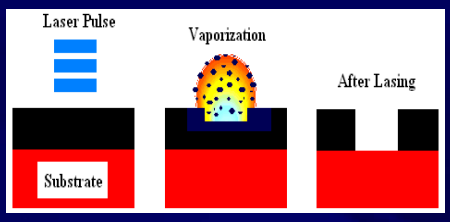
IMT Laser Socket Cleaning

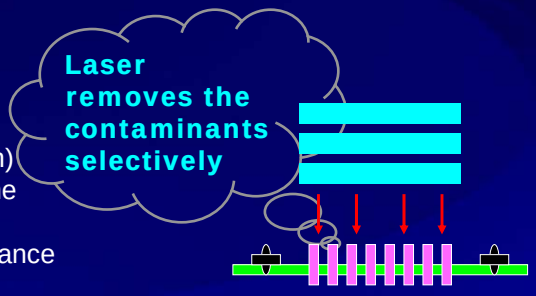
- **What is a laser cleaning?**

  : Dry cleaning technique to remove the surface contamination selectively without inducing any substrate damage by using proper laser beam interaction



- **Definition of Socket laser cleaning**

  : Removal Process of Tin(Sn) based contamination from the tester socket pin surface to improve the contact performance



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Advantages of Laser Cleaning

- In-situ cleaning without removing the socket
- High speed cleaning: approx. 10 sec/socket
- Excellent cleaning performance
- Immediate test yield increase (Approx. >2%)
- Very fast response process for emergency cleaning
- Very simple and easy handling process
- Low cost of ownership

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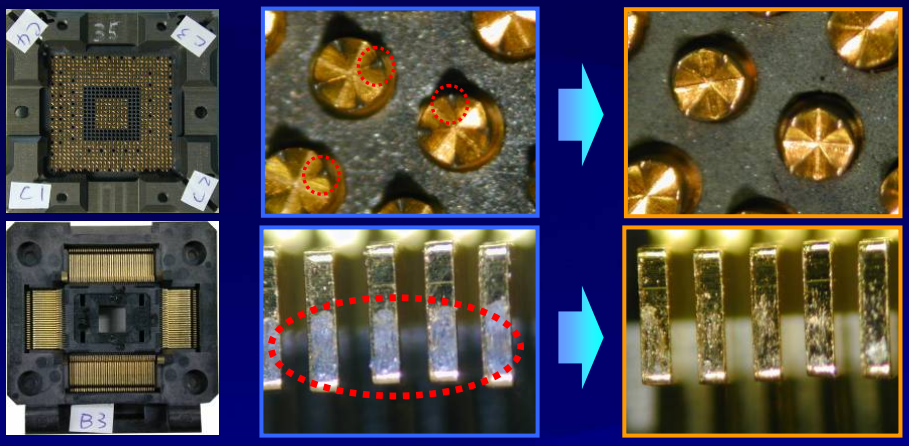
Laser Cleaning Results: Logic Sockets

- **Target of Test Socket Cleaning**
  : To remove Tin(Sn) based contamination from pogo-pin surface



Before cleaning | After cleaning

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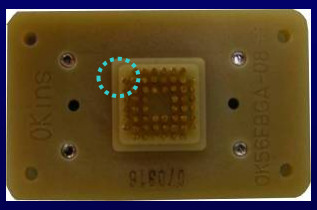
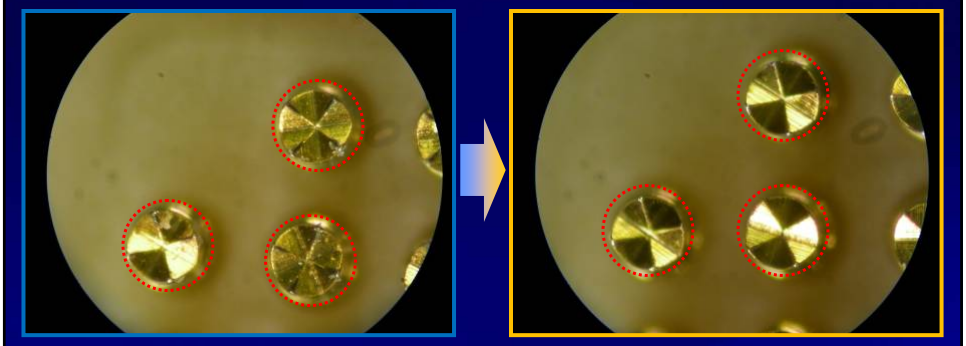
Memory BGA Socket

- Pogo pin laser cleaning





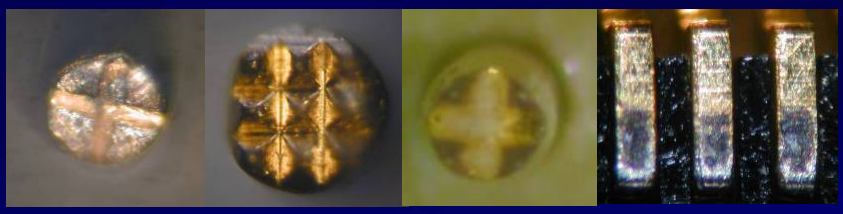
Before Laser Cleaning | After Laser Cleaning

3/2010 Socket Cleaning with Laser 10

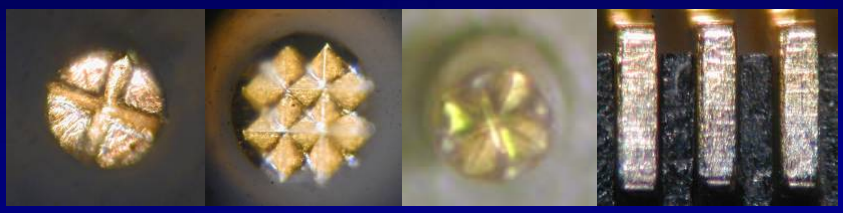
Various socket pins

- **Test Summary**
  : Laser can clean most of pin types without causing any substrate damages in the test sockets.

Before



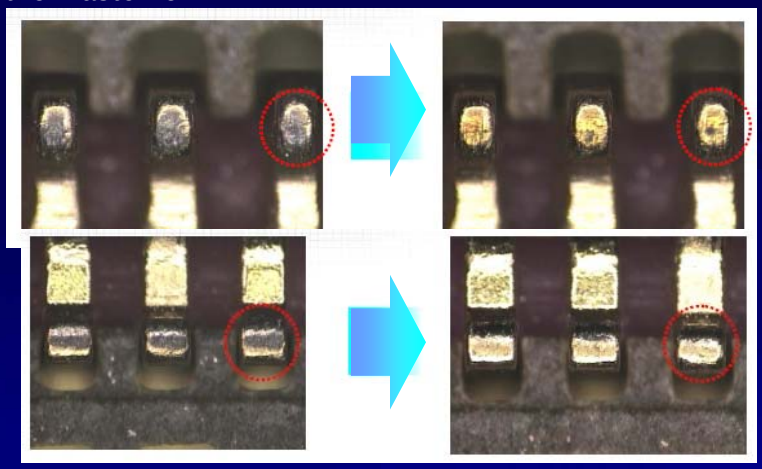
After



3/2010 Socket Cleaning with Laser 11

Laser Cleaning Results: Johnstech socket

- **Johnstech – S pin**: Pins can be cleaned without any damages of the Elastomer

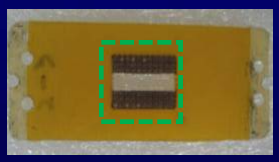


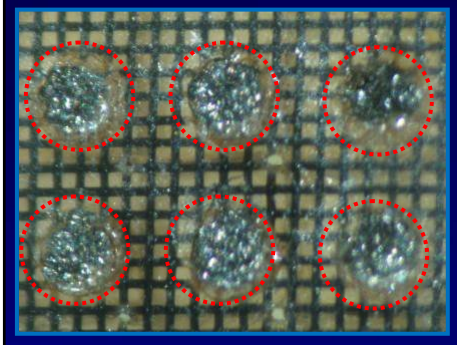
Before cleaning After cleaning

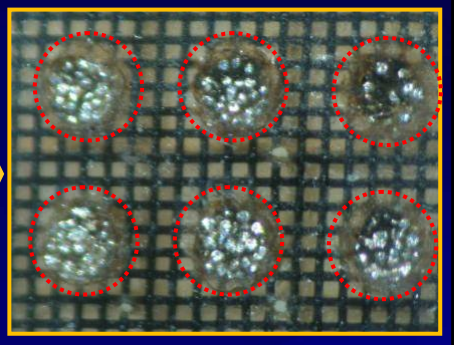
3/2010 Socket Cleaning with Laser 12

OKins Rubber Socket

- Contact cleaning after 100K touch down







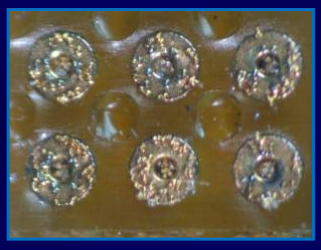
Before Laser Cleaning

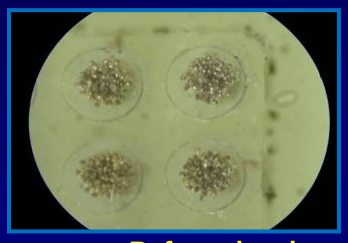
After Laser Cleaning
1. No physical damage to elastomer
2. 50% reduction in contact resistance

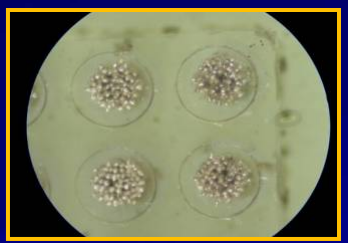
3/2010 Socket Cleaning with Laser 13

ISC Socket – Au & Ag powder

- **ISC-Silicon contactor**: Well cleaned without any damages







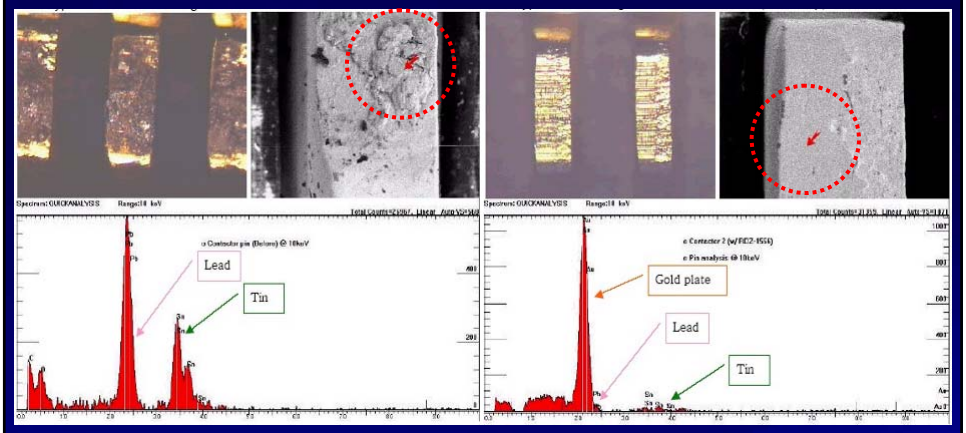
Before cleaning

After cleaning

3/2010 Socket Cleaning with Laser 14

Composition Analysis after Laser Cleaning

- EDS Composition Analysis Results



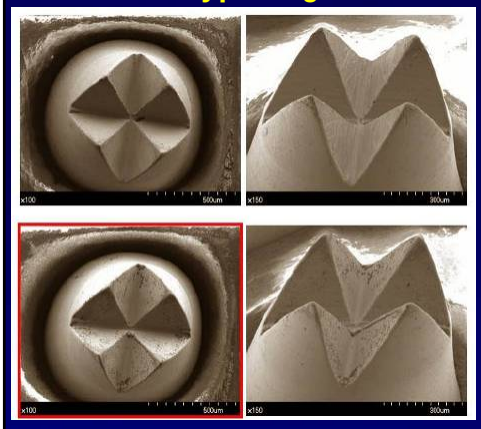
Before Cleaning

After Laser Cleaning:
Most Sn, Pb removed

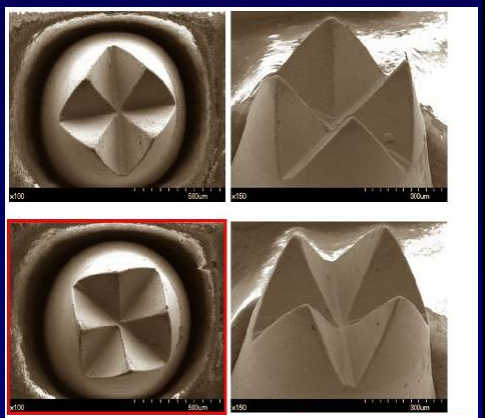
3/2010 Socket Cleaning with Laser 15

SEM Analysis before and after Cleaning

- Crown type Pogo Pin



Before Cleaning

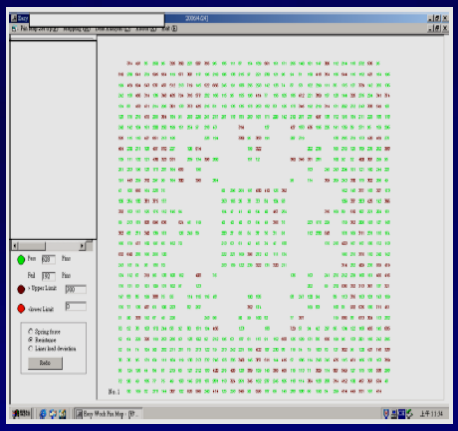


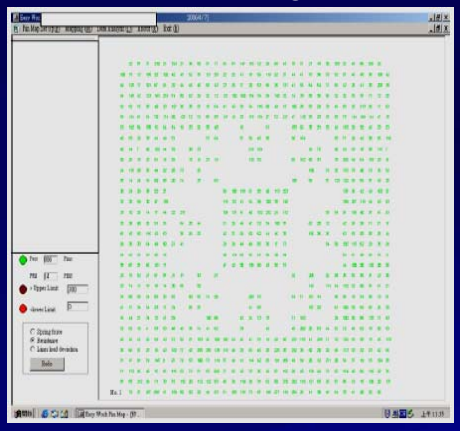
After Cleaning 100 times with laser: Clean Pin, with NO damage to the Pin surface.

3/2010 Socket Cleaning with Laser 16

Verification with Socket Test System
(Contact Resistance Measurement)

- S-com test data before and after laser cleaning





Before Laser Cleaning

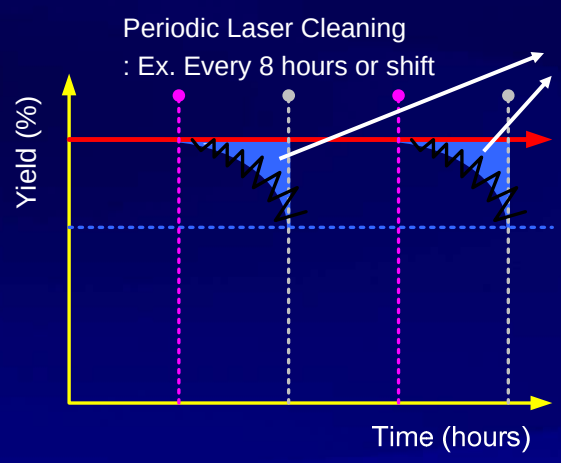
After Laser Cleaning:
All Cres within spec.

Yield Enhancement by laser socket cleaning

#06 => MLF10x10_64LD (Pogo)						
Before LC	Total: 2,572 Unit			After LC	Total: 3,896 Unit	
Good	(BIN1) 2,314	90%		Good	(BIN1) 3,752	96.3%
Reject	(BIN5) 167	6.5%		Reject	(BIN5) 128	3.3%
	(BIN6) 13	0.5%			(BIN6) 13	0.3%
	(BIN5) 8	0.3%			(BIN5) 9	0.2%
#11 => BGA 13x13 (Pogo)						
Before LC	Total: 1,495 Unit			After LC	Total: 3,104 Unit	
Good	(BIN1) 1,265	84.6%		Good	(BIN1) 2,809	90.5%
Reject	(BIN3) 42	2.8%		Reject	(BIN3) 50	1.6%
	(BIN5) 19	1.3%			(BIN5) 25	0.8%
	(BIN6) 97	6.5%			(BIN6) 109	3.5%
	(BIN7) 81	5.4%			(BIN7) 118	3.8%

In-Situ Socket Cleaning for Yield Management

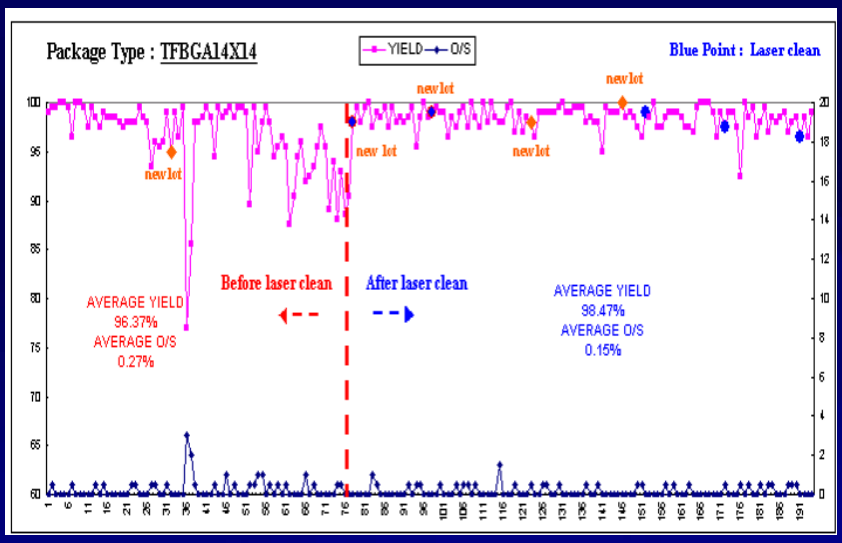
- Maintain High Yield by Laser Cleaning



=> Maintain High Yield with On-line Laser Cleaning
=> Typical Conventional Cleaning or Socket replacement cycle

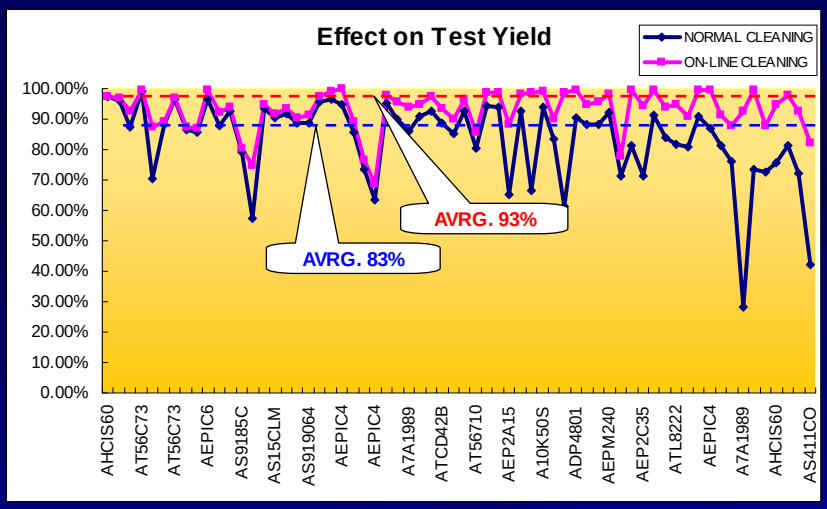
3/2010 Socket Cleaning with Laser 19

In-situ On-line Cleaning Result – Yield Control



3/2010 Socket Cleaning with Laser 20

Cleaning Impact – First Yield Up



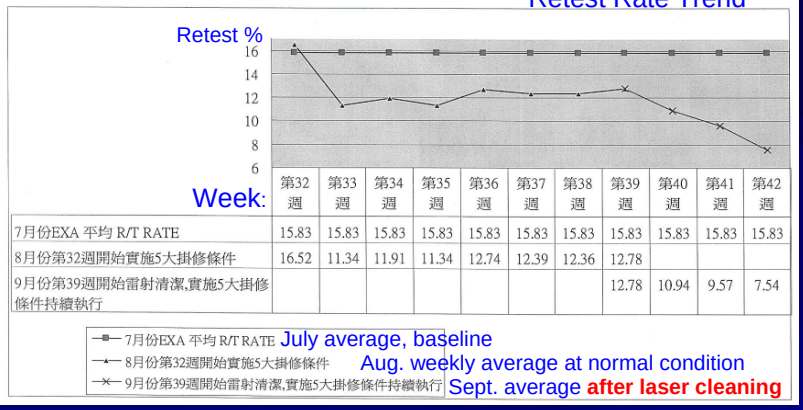
❖ Test yield increase of 10%, with online laser cleaning

Cleaning Impact – Retest Reduction

A Customer's Experience, Taiwan:

EXA R/T RATE 比較圖

Retest Rate Trend



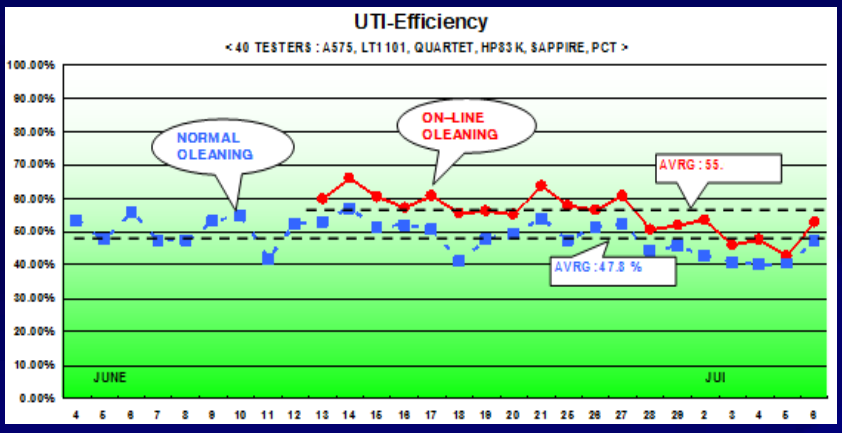
July average, baseline

Aug. weekly average at normal condition

Sept. average **after laser cleaning**

❖ Reduction in retest % is more than 5%

Cleaning Impact - Machine UTI Efficiency Up



❖ Machine Utilization Efficiency increased by ~ 7% after on-line laser cleaning, compared with normal blush cleaning –pogo socket

3/2010 Socket Cleaning with Laser 23

Examples of Commercially Available Tools

Mobile & Manual

For on-line socket cleaning

Automatic

For off-line board cleaning – HiFix board

Socket Test & Cleaning

For socket maintenance

3/2010 Socket Cleaning with Laser 24

Online Cleaning Operation – with mobile cleaning system

Online cleaning operation at a customer site

3/2010 Socket Cleaning with Laser 25

Socket Test & Cleaning System

- **Automatic Socket Test & Cleaning System**

1. **Automatic laser cleaning of pins**
2. **Automatic pin quality test (Cres, Force, Displacement)**

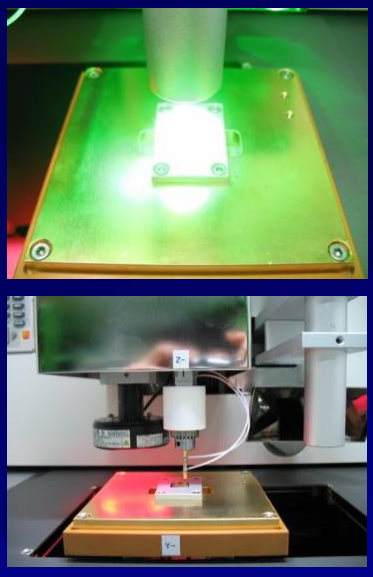
- **Benefits**

1. **Significant Pin Cost Saving**

   : For fine pitch & expensive pins

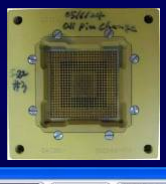
2. **Easy Socket Maintenance**

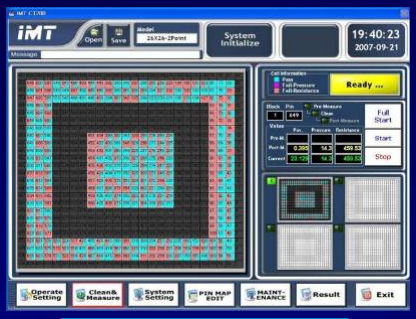
   : Fully Automatic handling for operators



3/2010 Socket Cleaning with Laser 26

Cres & Spring Force Test Result





	Block 1							
	Before cleaning				After cleaning			
Pin No.	Position	Pressure	Resistance		Position	Pressure	Resistance	
28	0.41	14.8	183.49		0.41	14.9	156.91	
29	0.41	14.7	1.00E+10	RF	0.41	14.8	356.26	RF
30	0.41	14.8	1059.97	RF	0.41	14.5	165.25	
31	0.41	14.9	1.00E+10	RF	0.41	14.5	432.81	RF
32	0.41	14.8	1.00E+10	RF	0.41	14.8	109.25	
33	0.41	14.8	1.00E+10	RF	0.41	14.1	594.26	RF
34	0.41	14.5	794.91	RF	0.41	14.7	429.19	RF
35	0.41	14.3	422.58	RF	0.41	14.7	104.23	
36	0.41	14.7	1.00E+10	RF	0.41	14.2	194.25	
37	0.41	14.9	1.00E+10	RF	0.41	13.9	350.6	RF
38	0.41	14.6	480.2	RF	0.41	15.5	147.56	
39	0.41	14.3	1.00E+09	RF	0.41	14.6	156.54	
40	0.41	14.5	734.36	RF	0.41	14.2	159.56	
41	0.41	14.9	266.06		0.41	13.2	148.29	
42	0.41	14.5	252.54		0.41	14.1	152.96	
43	0.41	13.2	1844.6	RF	0.41	16.3	146.28	
44	0.41	15.1	1.00E+10	RF	0.41	15.2	197.25	
45	0.41	14.6	760.64	RF	0.41	15.5	193.27	
46	0.41	14.7	451.51	RF	0.41	15.3	158.89	
47	0.41	13.8	299.78		0.41	13.3	147.52	
48	0.41	14.1	421.56	RF	0.41	12.9	198.26	
49	0.41	14.3	221.01		0.41	13.9	185.39	
50	0.41	14.3	218.05		0.41	13.3	193.49	
51	0.41	13	2855.3	RF	0.41	13.2	149.67	

***Red: Fail, Spec Out**
***Blue: Fine, Spec In**

*** 13 out of 18 failed pins passed after laser cleaning. **(Recovery Rate = 72%)**

3/2010 Socket Cleaning with Laser 27

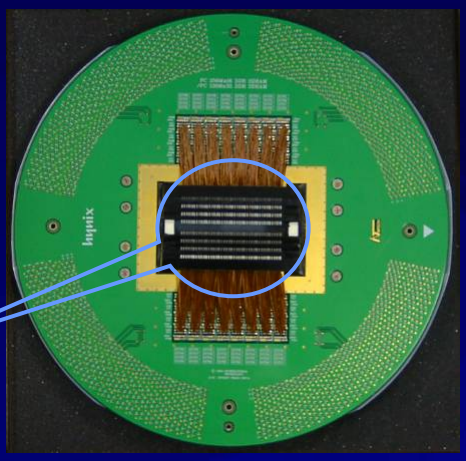
Conclusions – Laser cleaning can

- Improve the pin contact quality without any damage
  1. Contact resistance reduction: ~ 50%
  2. Suitable for most socket types (BGA, SOP, QGN, Rubber / elastomeric…)
- Verify test socket performance
  1. Test New socket (pins) quality (incoming inspection)
  2. Extend the socket life by cleaning and recycling the contact pins.
- Enhance the test Yield
  1. Yield Improvement: as much as 5%
  2. Reduction in system downtime

3/2010 Socket Cleaning with Laser 28

Other Application: Probe Card Cleaning

- Probe Cards
- Cleaning target
  : Probe Pin surface contaminated by continuous contacts with wafer

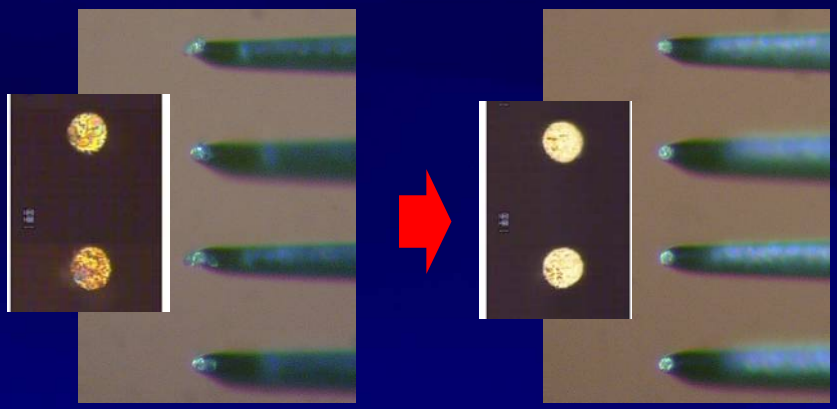


Cleaning Area

3/2010 Socket Cleaning with Laser 29

Cleaning Result: Cantilever Probe Card

- Probe Surfaces Before & After Cleaning (x50)



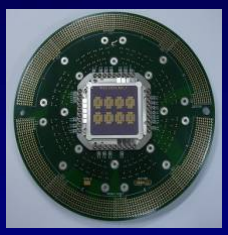
Before Cleaning ***After Cleaning***

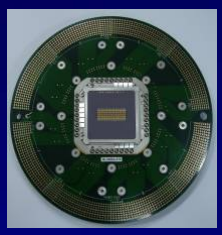
3/2010 Socket Cleaning with Laser 30

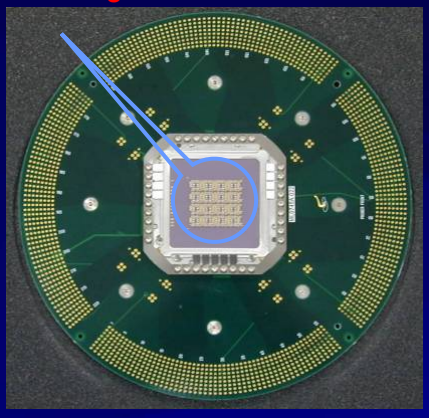
MEMS Probe Card Cleaning

- MEMS Probe Card (FormFactor)

Cleaning Area

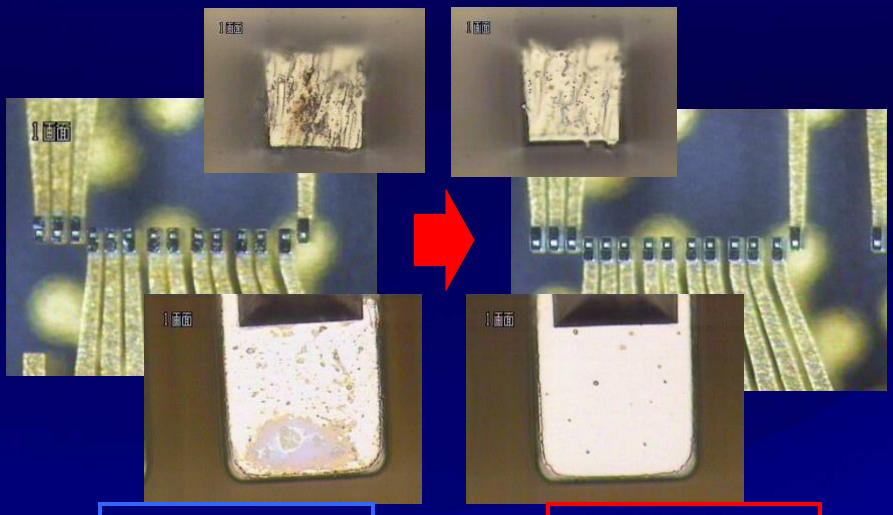






3/2010 Socket Cleaning with Laser 31

Cleaning Result – Well & Easily cleaned



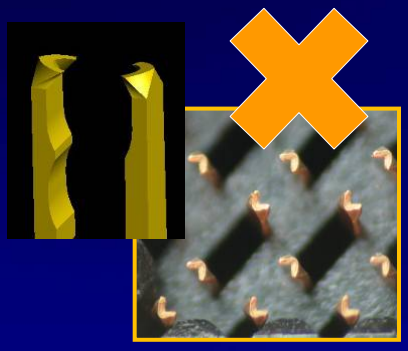
Before Cleaning

After Cleaning

3/2010 Socket Cleaning with Laser 32

Burn-in Board Socket Cleaning with Laser

- Very effective for Buckle beam type BIB sockets
- Not suitable for pinch type BIB sockets



3/2010 Socket Cleaning with Laser 33

An Environmentally Responsible Test During Burn-In System Design

Bill Barraclough
Don Richmond
Aehr Test Systems

2010 BiTS Workshop
March 7 - 10, 2010

The Challenge:

We are all challenged, in our personal and professional lives, to reduce costs AND be environmentally responsible.

Related to semiconductor test equipment: is it practical to both reduce costs AND be environmentally responsible?

The answer can be YES!

Specific examples where equipment designers & users can reduce cost AND be environmentally responsible are provided.

3/2010 An Environmentally Responsible Test During Burn-In System Design 2

Environmentally Responsible Burn-in & Test?

- Attributes to look for in your equipment:
  - Energy efficiency
  - Facility requirements / costs
  - Throughput, capacity, utilization
  - Test capabilities to enable offload of final test
  - Conformance to industry environmental standards
  - Reliability, uptime

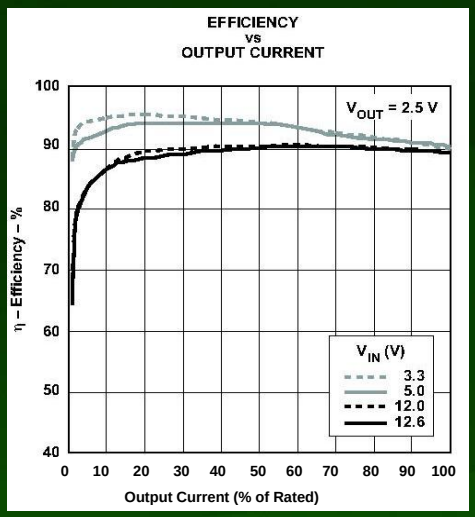
3/2010 An Environmentally Responsible Test During Burn-In System Design 3

Energy Efficiency

- Advances in switching supplies used for device power enables >90% efficiency
  - Eliminates need for linear regulation which also increases efficiency. More power to the DUT, less wasted for regulation overhead.
  - Reduces need to cool system electronics.
- Low cost of DC-DC switchers enables use of many small DUT supplies
  - Power supply efficiency is highest near maximum current.
  - Idling unneeded power supplies that are connected in parallel allows delivered power supply current to more closely match DUT / BIB needs at a higher efficiency.
  - Allows over current detect per DUT, individual DUT shutdown and avoids need to reprocess hostage DUTs.

3/2010 An Environmentally Responsible Test During Burn-In System Design 4

Energy Efficiency



3/2010 An Environmentally Responsible Test During Burn-In System Design 5

Energy Efficiency

- Using higher voltage and lower current in the system power architecture reduces “Lost” power
- Lower device voltages & higher currents maximize savings / benefits
- Having a low power stand-by mode for system electronics saves power when the system or slots are idle

3/2010 An Environmentally Responsible Test During Burn-In System Design 6

Reducing "Lost" Power

Older System Power Architecture

	208VAC In	Wiring Loss	Variable Switching Bulk Supplies (4.55V)	Bulk Power Distribution	Not Applicable	Regulation to DUT voltage (3.3V)	Distribution to BIB	Available DUT Power (3.3V @ 100A)
Power Loss (%)		0.150%	15.600%	0.440%		27.400%	0.910%	0.000%
Power Out (%)	100.00%	99.85%	84.27%	83.90%		60.91%	60.36%	60.36%
Current Out (A)	2.6	1.9	100	100		100	100	100

Overall Loss 39.64%

Newer System Power Architecture

	208VAC In	Wiring Loss	Fixed 48V Bulk Supplies	Bulk Power Distribution	Intermediate Bus Converters (12V)	Variable DC:DC Device Supplies (3.3V)	Distribution to BIB	Available DUT Power (3.3V @ 100A)
Loss (%)		0.050%	6.500%	0.003%	5.800%	4.700%	0.910%	0.000%
Power Out (%)	100.00%	99.95%	93.45%	93.45%	88.03%	83.89%	83.13%	83.13%
Current Out (A)	1.9	1.9	7.7	7.7	29	100	100	100

Overall Loss 16.87%

3/2010 An Environmentally Responsible Test During Burn-In System Design 7

Cost of "Lost" Power

In order to deliver 3.3V @ 100A = 330W per BIB	Older Systems	Newer Systems
Output Power (W)	330	330
Power Loss (%)	39.64%	16.87%
Required Input Power (W)	546.7	397.0
Lost Power (W)	216.7	67.0
Reduction in Lost Power (%)		**69.10%**
Reduction in Lost Power/Slot (W)		149.8
Reduction in Lost Power per 72 Slot System (W)		10,782
Reduction in Lost Power assuming 20 hour usage, 350 days per year (KWH)		75,475
Savings per year based on power cost of $0.20 per KWH		**$15,095**

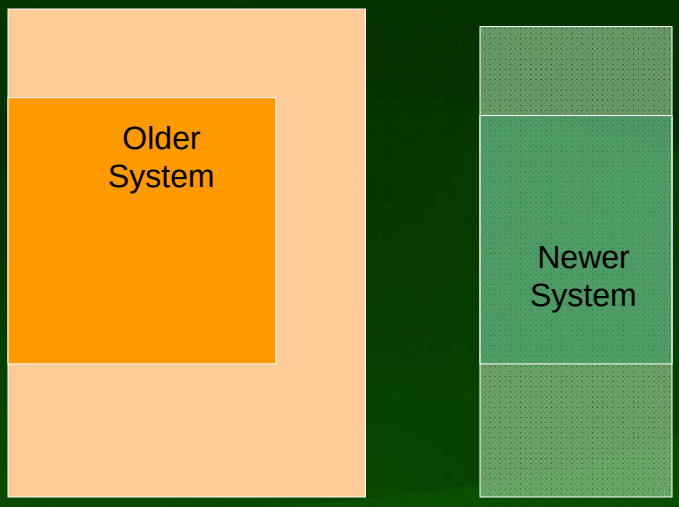
3/2010 An Environmentally Responsible Test During Burn-In System Design 8

Facility Requirements / Costs

- New systems can greatly improve utilization of floor space
  - Cost per square meter of floor space increasing
  - Minimizes need for factory expansion
  - New low power systems can require 1/2 the floor space of older systems
  - New high power systems can provide significantly more capacity than older systems
    - ➔ Dramatic increases in utilization of floor space

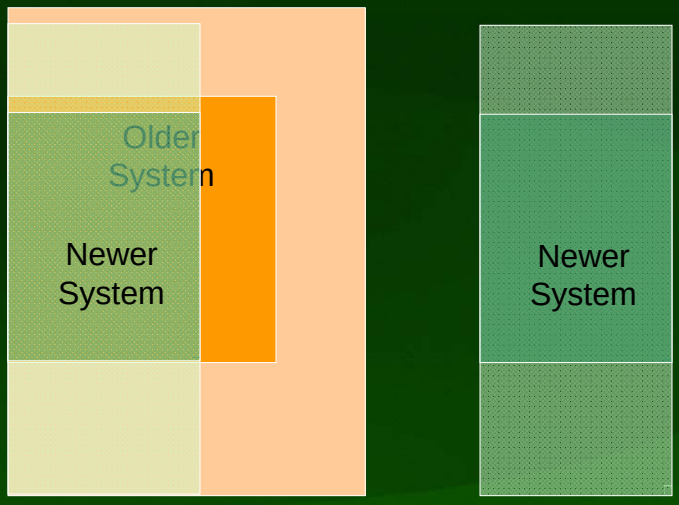
3/2010 An Environmentally Responsible Test During Burn-In System Design 9

Floor Space Utilization Comparison for Low Power Systems



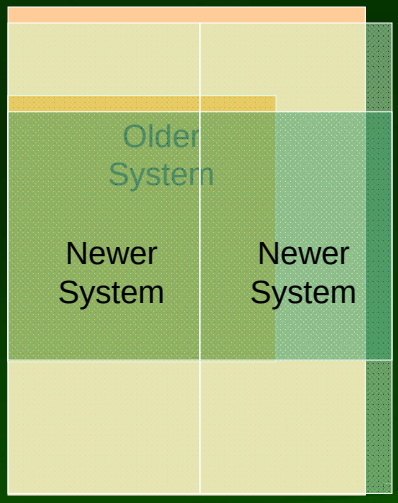
3/2010 An Environmentally Responsible Test During Burn-In System Design 10

Floor Space Utilization Comparison for Low Power Systems



3/2010 An Environmentally Responsible Test During Burn-In System Design 11

Floor Space Utilization Comparison for Low Power Systems



- No Side Access

  ➔~Twice as many systems in the same floor space
- More BIB slots per system

  ➔~2.5 times number of DUTs in the same floor space

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Floor Space Utilization Comparison for High Power Systems

- Assumptions:
  - Newer systems have about the same footprint as older systems
  - Test resources (available current and power) per BIB are comparable in older and newer systems
  - Oven power dissipation in older and newer systems is not a limiting factor
  - System capacity is therefore approximately proportional to the number of BIBs or total BIB area in older vs. newer systems

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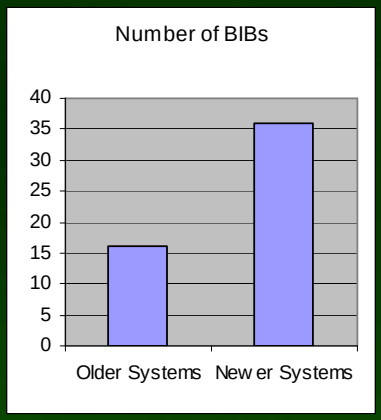
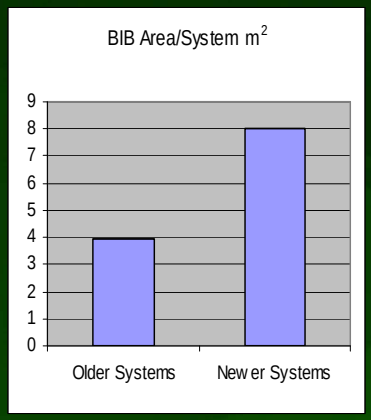
Floor Space Utilization Comparison for High Power Systems

- Older system capacity
  - 16 BIBs, each having a useable area of .248 m^2 for a total BIB area of 3.968 m^2
- Newer system capacity
  - 36 BIBs, each having a useable area of .223 m^2 for a total BIB area of 8.026 m^2

3/2010 An Environmentally Responsible Test During Burn-In System Design 14

Floor Space Utilization Comparison for High Power Systems





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Other Facility Considerations

- Effective use of aisles and service corridors enables more effective use of floor space
  - Service access from front and rear only
  - Retractable doors to keep aisles clear
- Reduced utility requirements for additional energy savings
  - Utilize lowest cost facilities (e.g. factory chilled water instead of air conditioning)

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Throughput, Capacity, Utilization

- An underutilized tool is wasting energy and facilities
  - PG per driver allows mixed lots & higher utilization
  - Higher airflow & uniformity permits smaller or no heatsinks, reduces need for expensive individual temp control

    ➔ increased # of DUTs per run
- Accurate temperature & voltages allow optimized Burn-in times

  ➔ increased # of runs per day

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Throughput, Capacity, Utilization

- A “down” system is wasting facility and manpower resources
  - Ways to reduce downtime, increase availability
    - Redundant, hot swap power supply architecture reduces down time
    - Hot swappable electronics enables rapid repair without turning the system off
    - Independent resources per slot increases availability
    - Self diagnostics can quickly identify failures

      ➔ Fewer (excess) systems required

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Improve Facility Utilization with Final Test Offload

- Increase system utilization by combining test and burn-in
  - Perform long functional tests in a highly parallel environment
  - Offload long functional tests from final test
  - Implementing DFT/BIST enhances value of test during burn-in
    - Better test coverage in burn-in/test system
    - Decreases required complexity of burn-in/test system

  ➔Decreases cost by decreasing number of expensive testers needed

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Environmental Considerations

- New systems should conform to environmental standards
  - e.g. RoHS (Reduction of Hazardous Substances)
- Consumption and disposal of hazardous materials should be eliminated or minimized
  - e.g. fluorocarbons, lubricants
- Recycle / reuse plans are now being required before purchase
  - Flexibility & expandability can insure long useful life

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What can equipment users do?

- Optimize burn-in times & process conditions
  - Optimize burn-in duration via higher voltage and temperature
    - Enabled by more accurate voltage and temperature control
  - Optimize burn-in times via “smart” burn-in algorithms
- Use environmentally responsible test boards & sockets
  - Use RoHS compliant materials and processes
  - Maximize material utilization / fab panel sizes

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What can equipment users do?

- Make more effective utilization of burn-in and test equipment
  - Maximize capacity (run multiple lots, mixed products, etc)
  - Utilize parallel testing to reduce cost / off-load final test
  - Minimize facility requirements (space, utilities, etc)
- Demand environmental responsibility from your suppliers!

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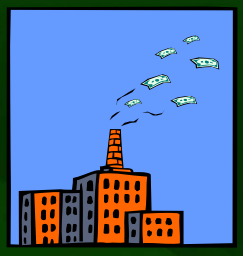
Conclusion



It is possible to design (and use) burn-in & test equipment that is environmentally responsible AND reduce costs.

We hope that some of these ideas will enable you to be more conscientious in your equipment selection and utilization.

3/2010 An Environmentally Responsible Test During Burn-In System Design 23