THIRTEENTH ANNUAL
BiTS 2012
Burn-in & Test Strategies Workshop

Session 4

ARCHIVE 2012

MAKING CONTACT

For many socket and probe card manufacturers the pins are the secret sauce, especially when performing burn-in and test on today's devices that have increasingly finer pitch and smaller geometries. This session will feature three presentations offering different contact solutions. The first speaker presents a new technique for fine pitch applications that integrates a short wiping stroke. Next up is a high-volume low-cost stamped spring probe in development for burn-in sockets. The session closes with a presentation on a simple, yet effective contact pin geometry.

A New Short-wiping-stroke© (SWS) Technique for Fine Pitch Application

Mah Ying Hoe—JF Microtechnology
Jay Williams—Transcend Technologies, LLC

High Volume Low Cost Stamped Spring Probe Development

Samuel Park, A.J. Park—IWIN Co. Ltd.
Jimmy Johnson—Materion Brush Performance Alloys

Simple and Effective Contact Pin Geometry

Bert Brost, Marty Cavegn—Nuwix Technologies

A New Short-wiping-stroke© (SWS) Technique for Fine Pitch Application

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2012 BiTS Workshop
March 4 - 7, 2012

Topic

- Challenges
- Simplified IC testing solution
- Short-Wiping-Stroke (SWS) features
- SWS technique
- Why SWS technique?
- Robustness
- DC resistance setup
- Path resistance distribution
- Evaluation
- Beta site result
- Tip condition at 500K approx.
- SEM analysis-Tip
- Pin condition
- Pin profile > 500K insertions
- Condition > 500K insertions
- Upcoming innovation

Challenges

- Lead free compliance
- Fine-pitch & High lead count
- Mechanical reliability
- Debris generation
- Sawn burr avoidance
- Device lead/pad design
- Short chamfered corner pad

Simplified IC testing solution

Short-Wiping-Stroke© (SWS) technique

•Flexibility

•Easy configuration

•Compatibility

Short-Wiping-Stroke© (SWS) features

- Unique geometry profiling create superior "biasing" effect
- Motion Dynamic technique

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Motion dynamic

SWS Technique

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SWS Technique

- Provide sufficient mechanical contact force to device contact lead/pad
  - Enhance signal integrity
  - Enhance mechanical lifespan through optimum stroke length

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Why SWS Technique?

- One design for both Matte Tin and NiPdAu
- Short device pad
- Fine pitch
- Reliable contact
- Even force distribution
- Optimum stroke length

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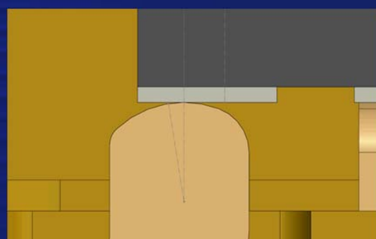
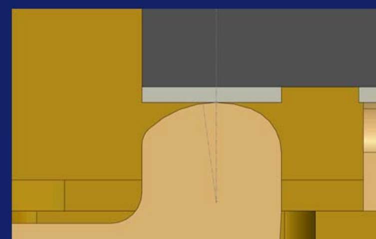
SWS Technique

Video clip



Conventional wiping



SWS

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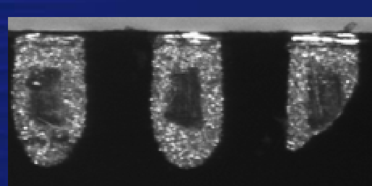
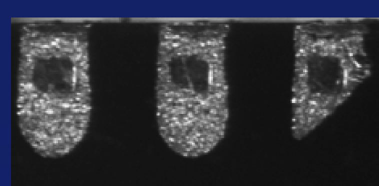
SWS Technique



Conventional wiping



SWS

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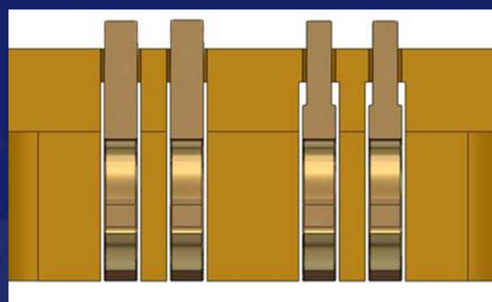
Robustness

- The geometry of the slot partition reliability improved by 25%
- 0.3mm pitch ready for leaded and pad package



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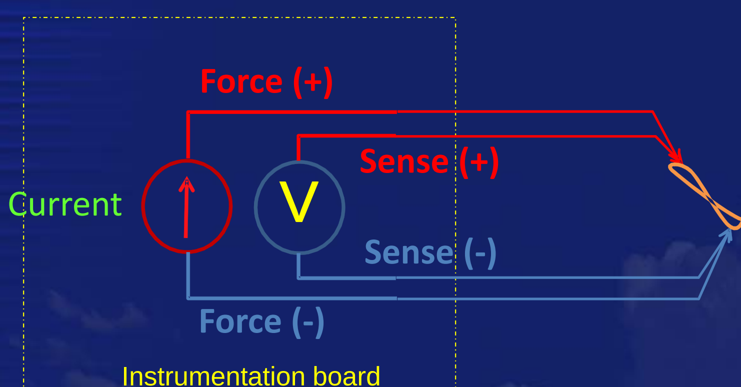
DC Resistance Setup



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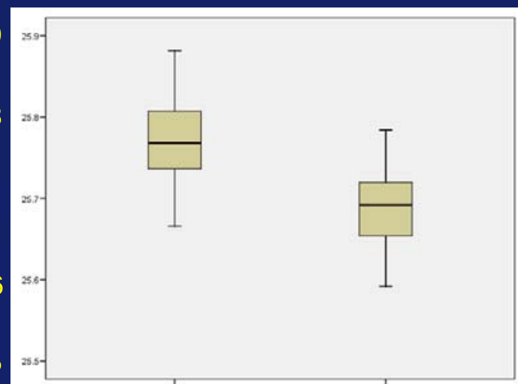
Path Resistance Distribution

Setting

Deflection: 0.2 mm

Gram force: 35 grams/pin

Distribution: 0.2 mΩ



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Evaluation

- Beta-site evaluation is the best practice examining the effects of testing matte tin and NiPdAu as the results going beyond an understanding of the underlying factors of the SWS technique effectiveness.

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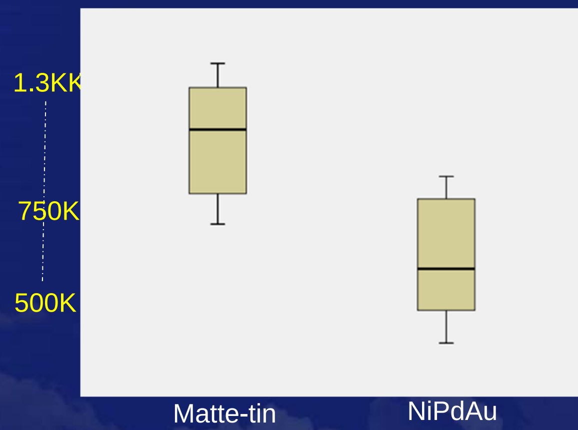
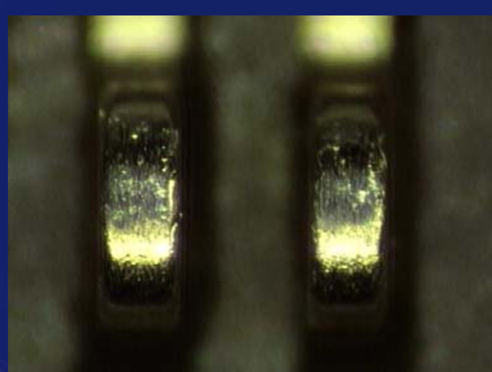
Beta Site Result



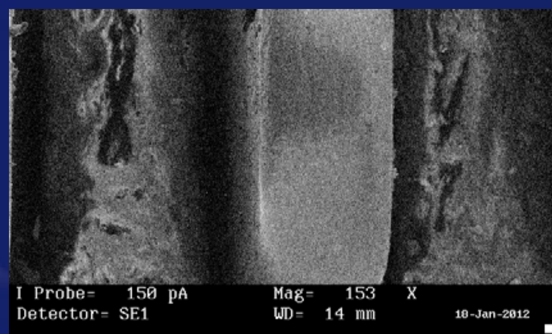
Preliminary result

Tip condition at >500K approx.



Minimum tin migration

SEM analysis-Tip



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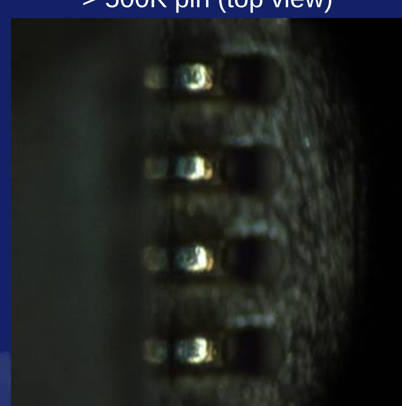
Pin condition

New pin (top view)

> 500K pin (top view)



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Pin profile > 500K insertions

- Minimum wear & tear

New pin (side view) | > 500K pin (side view)

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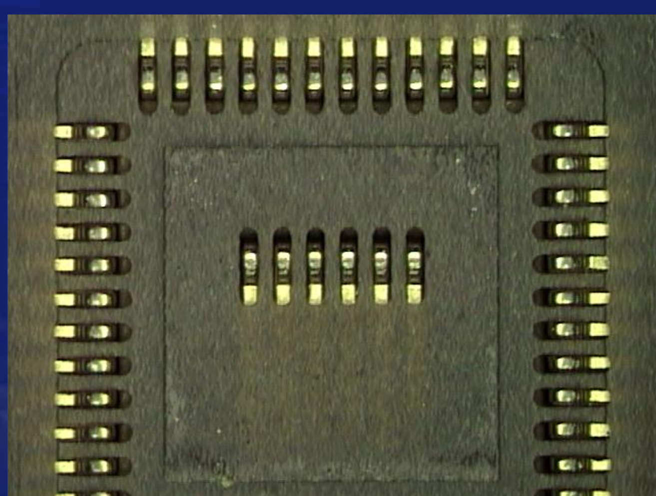
Condition > 500K insertions



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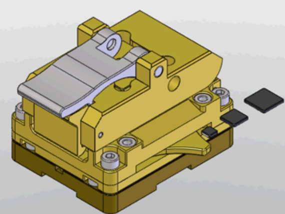
Upcoming Innovation

Auto Centering Manual Actuator (ACMA)

Video clip



Patent pending

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Conclusion

Short-Wiping-Stroke© (SWS)

•Satisfy most of the critical performance of the test package challenges (short pad, improve solderability area, finer pitching, sawn burr and sustainable test yield)

•Generate less debris, less wear & tear attribute to longer MTBA and lower Cost of Ownership.

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High Volume Low Cost Stamped Spring Probe Development

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2012 BiTS Workshop
March 4-7, 2012

Brush Performance Alloys

Presentation Outline

- Why trials on stamping to make spring probe pin
- How to make coil spring by stamping
- One piece spring probe pin by stamping
- Three piece spring probe pin by stamping
- Electrical and mechanical performance & requirements
- Importance of material selection
- Lessons learned and next step

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Why Trials on Stamped Spring Probe?

- Easy for mass production and lead time management
- Easy for quality management
- Low cost enabling wider application of probe pins
- Finer pitch
- Shorter length for high speed test

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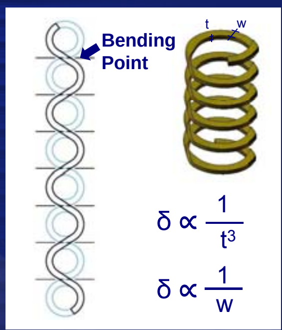
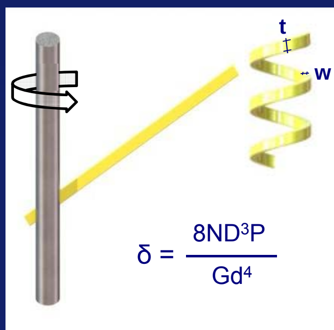
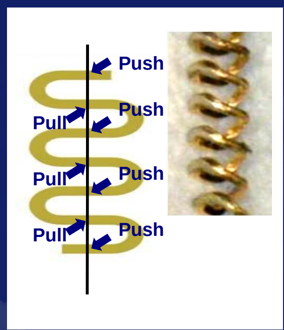
How to Make Coil Spring by Stamping

- A few ways to make a coil spring
- Characteristic of springs from the different ways of make







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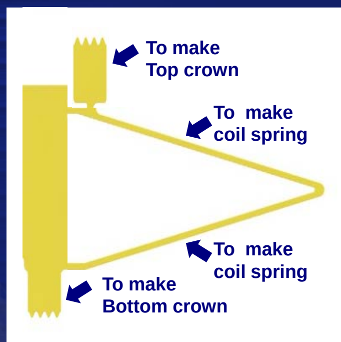
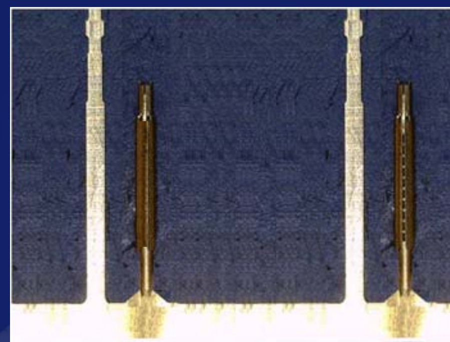
One Piece Spring Probe Pin by Stamping.

- Example 1.





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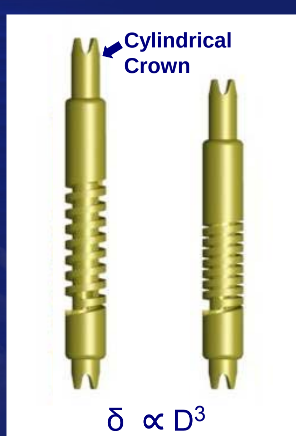
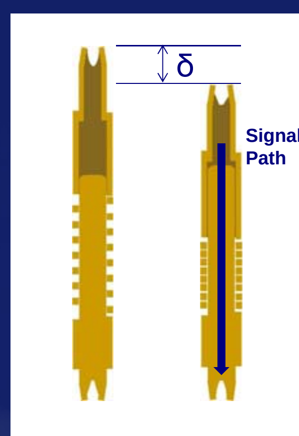
One Piece Spring Probe Pin by Stamping.

- Example 2.





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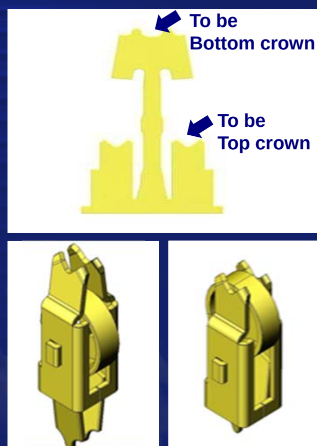
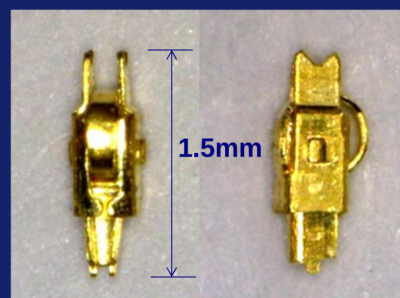
One Piece Spring Probe Pin by Stamping.

- Example 3. Spring probe pin with a plate spring





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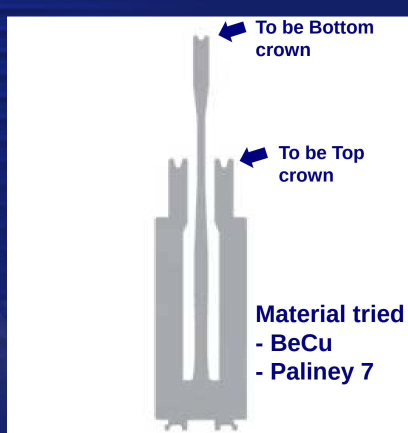
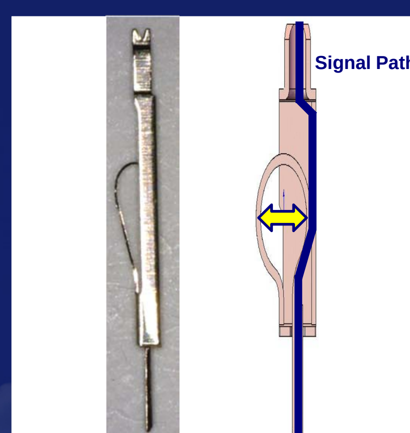
One Piece Spring Probe Pin by Stamping.

- Example 4. Spring probe pin with a plate spring





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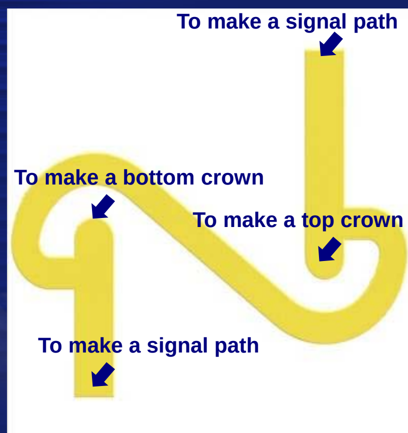
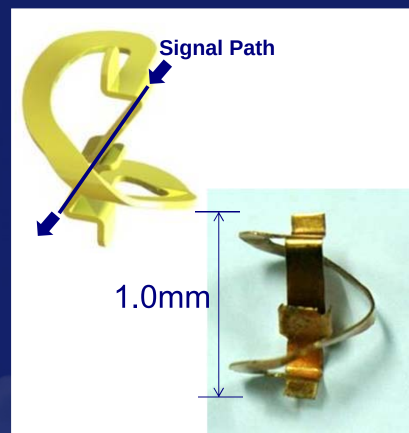
One Piece Spring Probe Pin by Stamping.

- Example 5. Spring probe pin with a plate spring





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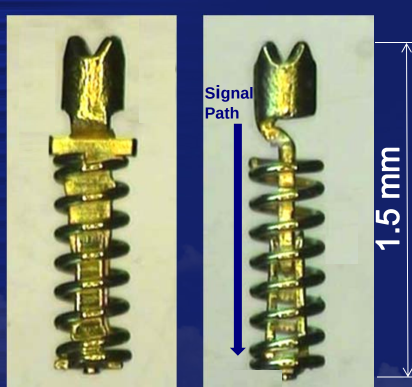
Three Piece Spring Probe Pin by Stamping

- Example 1.
  Hair pin shape spring probe with cylindrical crown



Front view Side view

- Can choose material as needed for plunger, bridge and spring
- Long stroke for short pin is possible
- Small outer diameter is possible

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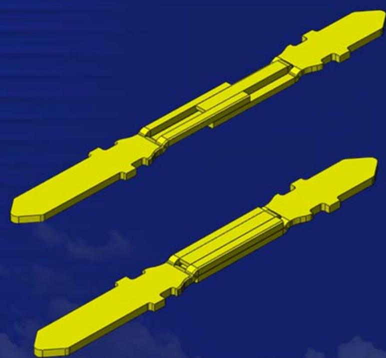
Three Piece Spring Probe Pin by Stamping

- Example 2. Spring probe pin with three bridges



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Electrical and Mechanical Performance Requirements

- To provide required stroke, spring force and life.
- Thickness of metal strip
- Diameter of spring probe pin.

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Material Selection (Typical High Performance Alloys Used in BiTS Applications)

- Alloy 25 (C17200)
  - Be 1.8 to 2.00%
  - Co + Ni 0.20% min
- Alloy 390 (C17460)
  - Be 0.15 to 0.50%
  - Ni 1.0 to 1.4%
- Alloy 390E (C17500)
  - Be 0.40 to 0.70%
  - Co 2.4 to 2.7%
- Alloy 3 (C17510)
  - Be 1.8 to 2.00%
  - Co + Ni 0.20% min
- Alloy 360 (NO3360)
  - Be 1.85 to 2.05%
  - Ti 0.4 to 0.6%

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Material Selection (Why use Alloy 25)

PHYSICAL PROPERTIES*

Elastic Modulus	Melting Point (Solidus)	Electrical Conductivity/ resistivity	Density**	Thermal Expansion Coefficient	Thermal Conductivity (25 °C)
19,000 ksi 131 GPa	1600°F 870 °C	22-28% IACS 6.2-7.8 μΩ-cm	0.302 lb/in³ 8.36 g/cm³	9.7x10⁻⁶ in/in °F 17.0x10⁻⁶ m/m °C	60 BTU/ft hr °F 105 W/ m K

MECHANICAL PROPERTIES*

Temper**	0.2% Offset Yield Strength		Ultimate Tensile Strength		Elongation***	Hardness	Formability (Minimum Bend Radius to Thickness Ratio for a 90° Bend)****	
	ksi	MPa	ksi	MPa	Percent	DPH	Longitudinal	Transverse
A (TB00)	30-55	190-380	60-78	410-540	35-65	90-144	0.0	0.0
¼ H (TD01)	60-80	410-560	75-88	510-660	20-45	121-185	0.0	0.0
½ H (TD02)	75-95	510-660	85-100	580-690	12-30	176-216	0.5	1.0
H (TD04)	90-115	620-800	100-120	680-830	2-18	216-287	1.0	2.9
AT (TF00)	140-175	960-1210	165-195	1130-1350	3-15	353-413	-	-
¼ HT (TH01)	150-185	1030-1300	175-205	1190-1420	3-10	353-424	-	-
½ HT (TH02)	160-195	1100-1350	185-215	1270-1490	1-8	373-435	-	-
HT (TH04)	165-205	1130-1420	190-220	1310-1520	1-6	373-446	-	-

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Lessons Learned From The Trials

- Importance of strip material selection
- Design for easier accuracy control for stamping yield
- Design for application, outside diameter, working temperature, stroke, numbers of insertion
- Paliney7 does not require gold plating, but high material cost

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Next Steps

- To serve finer pitch; Out diameter should be 0.2mm and less
- To serve high speed application; 0.55mm in length with 0.25mm stroke
- To reduce initial cost; Stamping tool design enabling various kinds of pin from one tool

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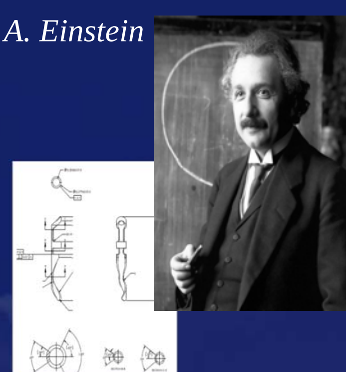
Simple and Effective Contact Pin Geometry

Bert Brost
Marty Cavegn
Nuwix Technologies

2012 BiTS Workshop
March 4 - 7, 2012

Development Point of View

- "Everything should be made as simple as possible, but not simpler." *A. Einstein*
  - Purpose
    - Make a good connection
  - Function
  - Engineering
  - Performance

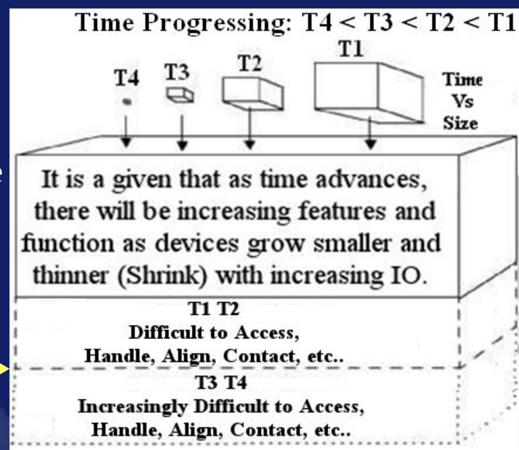


3/2012 Simple and Effective Contact Pin Geometry 2

Nothing is Getting Easier

- My father always insisted on buying the simplest piece of machinery available, arguing, "The more complicated it is, the more opportunities there are for something to go wrong."

However,
this is our reality.
How we deal with
it is up to us.



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Back to the Basics for Simplicity

- Preserve the integrity of the ball
- Make an electrical and a mechanical contact
- Ensure that contact witness marks must be close to the equator of the ball
- Minimize points of mechanical contact
- Preserve load board pads
- Reduce the number of moving parts

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Contactor Basics for Simplicity

- Provide a good wipe and self cleaning
- Avoid intermetalic migration
- Ensure repeatable self alignment
- Maintain pointing accuracy (allowable tolerance)
- Ensure forces in the Z, X, and Y do not deform or dislodge the ball
- Decouple forces from load board pads

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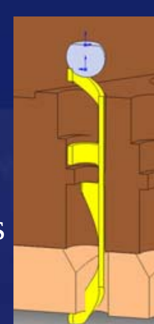
Shape, Size, Relative Position of Figures, and the Properties of Space

- **Geometric Advantages**
  - Making contact just below the equator of the ball for a highly repeatable low resistance connection in test
  - Making contact with the ball is made without puncturing or spearing the ball
  - Increasing run times and insertion counts between cleaning
    - The open hoop does not trap solder debris



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Simple Design
Feature – Fit – Function

- Offer a simple one piece construction
- Be compatible with existing test cell hardware
- Provide a wipe action when the device is contacted

New Fields of Use

- **Introducing:**
  - A new geometric concept for contacting with proven methodologies
  - A metal alloy is used for extension or torsion spring designs that resists solder buildup for:
    - Increasing contact pin life
    - Extending run times between cleaning

Contact First Surface: Metal Alloy and Geometry

- Gold plating can be an issue
  - Plating wear
  - Plating materials can crystallize with solder alloys
- With materials such as Paliney these problems are eliminated
  - We are not using Paliney, but the issues of failure associated with plating(s) needs to be understood and considered for a good interconnect

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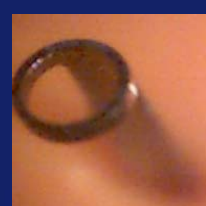
Contact First Surface: Size and Shape



- The contact hoop floats freely
- Open hoop does not trap debris
- Oxide removal and self cleaning:
  1. The hoop travels downward through an arc providing a rotational wipe
  2. The rotation is a progressive radial orientation to the point of contact with the mating solder ball

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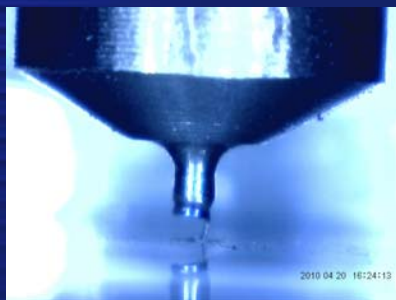
Early Testing



Sometimes the design was too simple.

Fundamental changes in shape and size (engineered geometry) were made to achieve the desired performance. Within the concept of being simple, there are mechanical stress points along with elastic and plastic material characteristics.

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Contact First Surface: Mechanical Performance Criteria

- The first surface is:
  - the physical boundary that separates one object from another
  - the solid conductive metal containing mobile or free electrons, originating the physical
  - the place where the softer surface yields to the harder surface
  - the number of first surface contact points must be kept to a minimum

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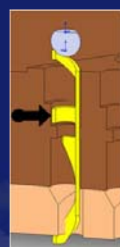
Contact First Surface: at the load board

- The softer surface will yield to the harder surface
- Decoupling DUT insertion force from load board pads

Insertion force decoupling mechanism



Contactor pin pattern on load board

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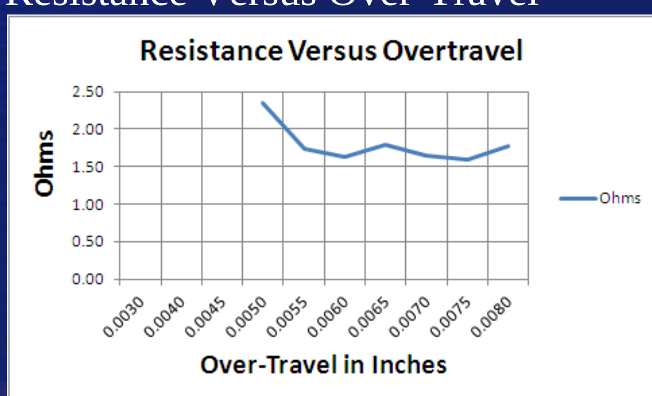
Field Testing 0.4 micro BGA

- Resistance Versus Over-Travel



R = 2 pins+2 balls+1 trace

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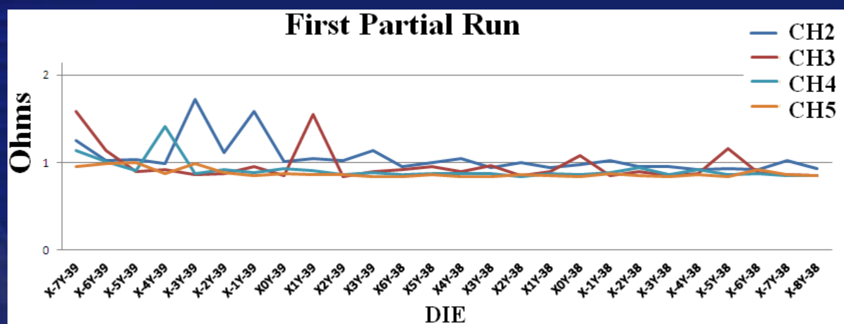
First Partial Run

- Contact Resistance and Insertion Count

R = 2 pins+2 balls+1 trace



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Contact Witness Marks

7X7 0.4mm Device
Multi Device Panel

Before After

Ball Shave

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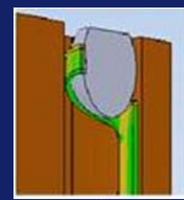
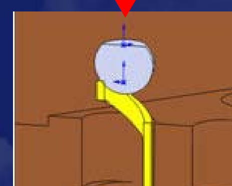
First Results

- Ball Shaving
  - Problem
    - Contact hoop was below the housing
  - Solution
    - Raise hoop above the housing



Before

After



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Conclusion

- Starting with a good idea, we have developed a simple and effective contact pin geometry planed to deliver long uninterrupted test runs at maximum insertion speeds with great yields.

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