BiTS Burn-in & Test Socket Workshop 2008

Poster Session 2

ARCHIVE 2008

"Kelvin Contacting"
Jim Brandes
Everett Charles Technologies

"Use Simulation to Obtain S Parameters and Network Parameters for Sockets and PCB/Connectors"
Sultan Faiz, Mike Fedde
Ironwood Electronics

"New Solution for Chipscale RF Lead Free ATE Test"
Sergio Diaz
Ardent Concepts, Inc.

"1mm Length Spring Probe: Practical? A Study of Spring Pin Dimension Limit"
Jiachun (Frank) Zhou, Praveen Matlapudi, Mark Murdza
Antares Advanced Test Technologies

"Challenges of Surface Mounted Test Sockets"
Dr. Shih-Wei Hsiao, Andrew Gattuso
Foxconn

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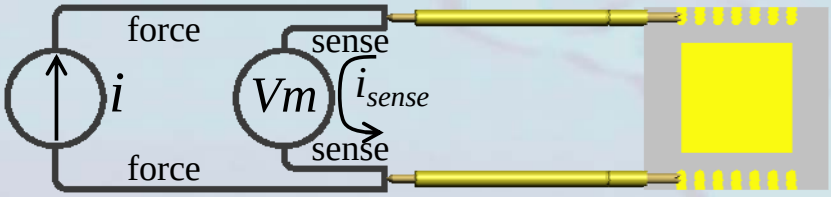
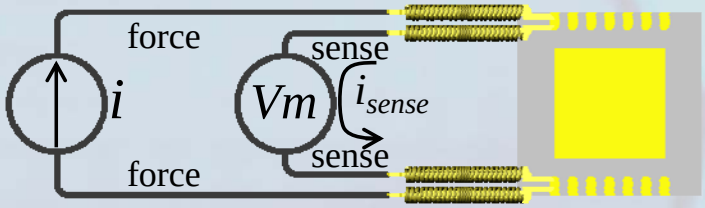
Kelvin Contacting

Electrical Solution

- Measuring low resistance values
  - Any value of a few Ohms should be considered
  - Definitely required if one Ohm or less
  - Implied low resistance, based on current and voltage parameters
- High accuracy voltage force or measure
- Voltage measurement under high current



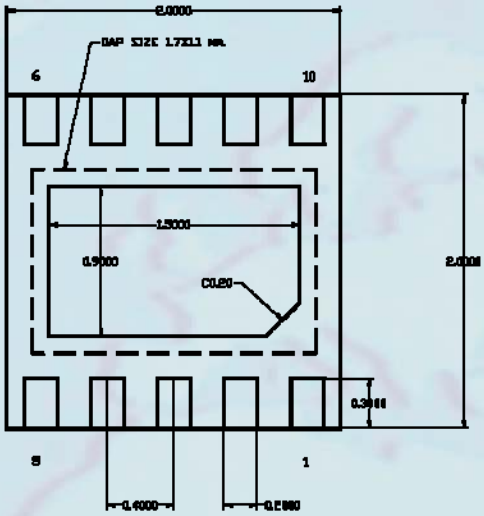


- Sense line current is infinitesimal
- Sense line voltage drop is negligible
- Any drop in the force path is compensated
- The closer the sense path is to the target the better
- Sense path all the way to the target is ideal

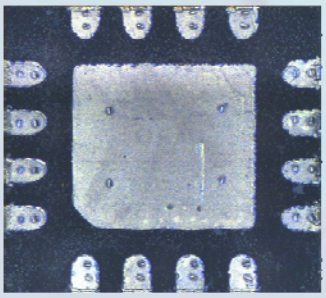
3/2008 Kelvin Contacting 1

Poster #1

Mechanical Challenge



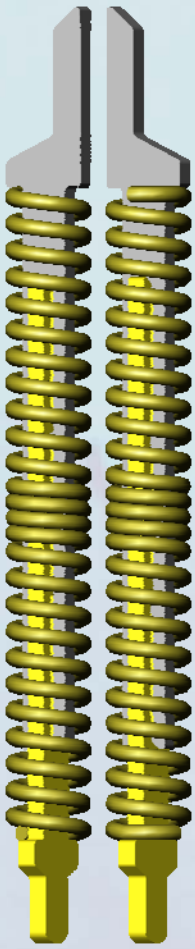
- Small Targets on Fine Pitch
- True Kelvin Requires Two Probes
  - Isolated Electrically
  - Independent Mechanically



Jim Brandes - Product Manager – ECT

Poster #1

Success: Gemini Kelvin™



- Customers Report Improved Test Yields
- Issues Related to Contact Resistance are Eliminated
- All Customers are Repeat Customers
- Over 75 Designs and Over 300 Contactors Shipped in First Year of Production
- Customers Reporting 250 k to 700 k Probe Life in High-Volume Production

Key Specifications:

Probe Pitch	0.4 mm and up (inline) 0.65 and up (array)
Kelvin Tip Spacing	0.15mm minimum
Board-Side Tip Spacing	0.45 mm
Loop Inductance	1.05 nH (single probe) 0.65 nH (dual probe)
Bandwidth	-1dB @ 14 GHz (single) -1dB @ 8 GHz (dual)
Contact Resistance	<150 mΩ (new probe)
Current Capacity	1.6 A Continuous (20º C rise) 6 A maximum @ 1% duty cycle

3/2008 Kelvin Contacting 3

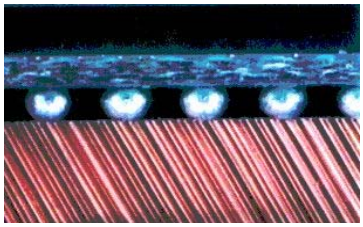
Poster #1

BiTS 2008

Use Simulation to Obtain S Parameters and Network Parameters for Sockets and PCB/Connectors:

Sultan Faiz & Mike Fedde

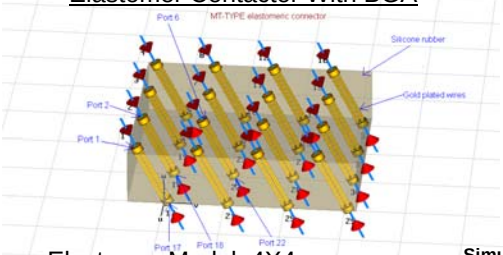
Ironwood ELECTRONICS



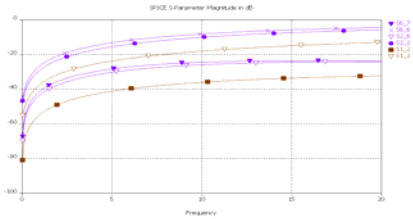
Elastomer Contactor With BGA

0.5mm GHz BGA socket simulation data

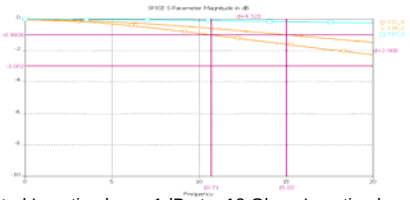
Elastomer Socket



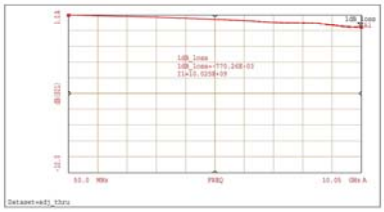
Elastomer Model, 4X4 array, 0,5mm pitch BGA



Simulated Return Loss and Crosstalk. S1_1 represents return loss at pin 1, S1_2 represents crosstalk between pins 1 and 2



Simulated Insertion loss: -1dB at > 10 Ghz. Insertion loss of pin 1 is represented by S17_1, pin 2 is S18_2, pin 6 is S22_6.



Actual Measured Insertion loss: -1 dB at > 10 GHz by Gigatest Labs

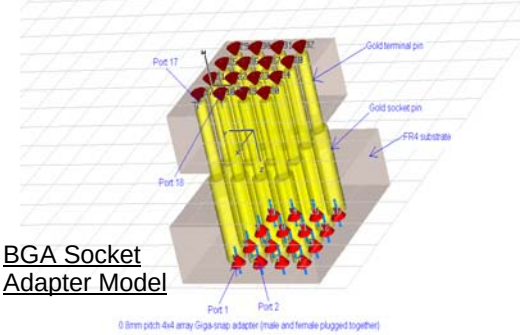
Capacitance (pF) to GND for all pins (1-16): 0.5mm GHz BGA socket			
0.0090	0.0052	0.0052	0.0090
0.0052	0.0049	0.0049	0.0052
0.0052	0.0049	0.0049	0.0052
0.0090	0.0052	0.0052	0.0090
Mutual inductance (nH) for some pins: 0.5mm GHz BGA socket			
Pin1	L_{12}=0.0031	L_{13}=0.00053	L_{14}=0.000036
L_{56}=0.0065	Pin6	L_{67}=0.01713	L_{68}=0.00172
L_{911}=0.00173	L_{1011}=0.01719	Pin11	L_{1112}=0.0065
L_{1316}=0.000037	L_{1416}=0.00055	L_{1516}=0.00307	Pin16
Self-inductance (nH) of the pins (1-16): 0.5mm GHz BGA socket			
0.0359	0.0516	0.0516	0.0359
0.0516	0.0595	0.0595	0.0516
0.0516	0.0595	0.0595	0.0516
0.0359	0.0516	0.0516	0.0359

High-speed sockets and adapters continue to perform important functions for IC component testing, prototyping, and production, requiring an ever-increasing level of electrical and mechanical performance. In the area of electrical performance, it is particularly important that an accurate predictive model be available for performance at GHz frequencies. High speed simulation data helps test engineers with initial selection of a proper interconnect design, and also serves as a predictor of performance over a variety of simulated end-use conditions. Note that measured and simulated insertion loss of elastomer contactor are within 2%.

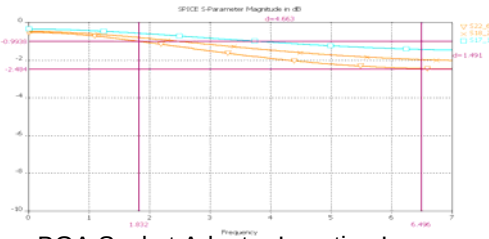
Poster #2

Giga-snaP and QFN adapter simulation data

BGA Socket Adapter

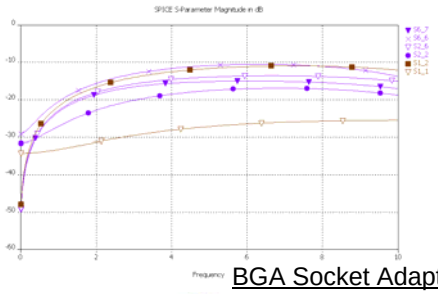


BGA Socket Adapter Model

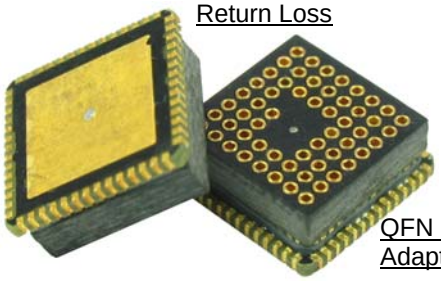


BGA Socket Adapter Insertion Loss

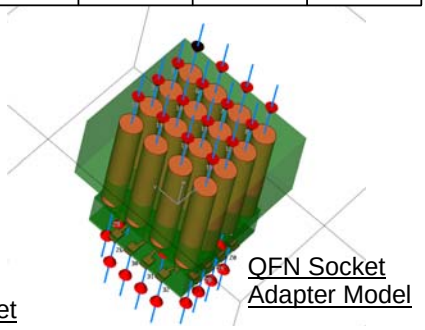
Capacitance (pF) to GND for all pins (1-16): Giga-snaP™ adapter			
0.2397	0.1080	0.1080	0.2397
0.1080	0.0054	0.0054	0.1080
0.1080	0.0054	0.0054	0.1080
0.2397	0.1080	0.1080	0.2397
Mutual inductance (nH) for some pins: Giga-snaP™ adapter			
Pin1	L_{12}=0.6412	L_{13}=0.3188	L_{14}=0.1666
L_{56}=0.6532	Pin6	L_{67}=0.6509	L_{68}=0.3455
L_{911}=0.3455	L_{1011}=0.6509	Pin11	L_{1112}=0.6532
L_{1316}=0.1665	L_{1416}=0.3188	L_{1516}=0.6412	Pin16
Self-inductance (nH) of the pins (1-16): Giga-snaP™ adapter			
1.5894	1.5798	1.5798	1.5894
1.5798	1.5690	1.5690	1.5798
1.5798	1.5690	1.5690	1.5798
1.5894	1.5798	1.5798	1.5894



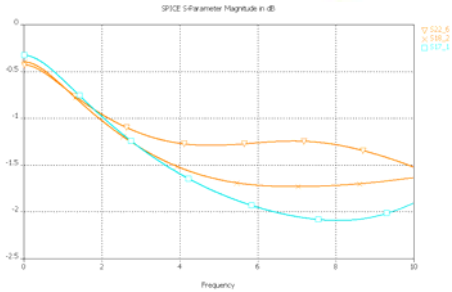
BGA Socket Adapter Return Loss



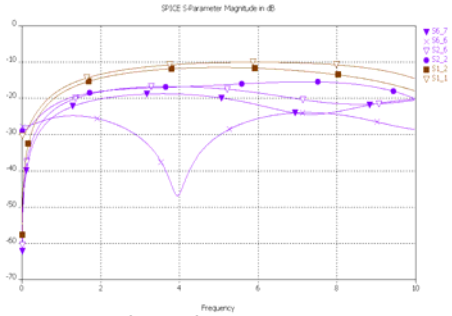
QFN Socket Adapter



QFN Socket Adapter Model



QFN Socket Adapter Insertion Loss

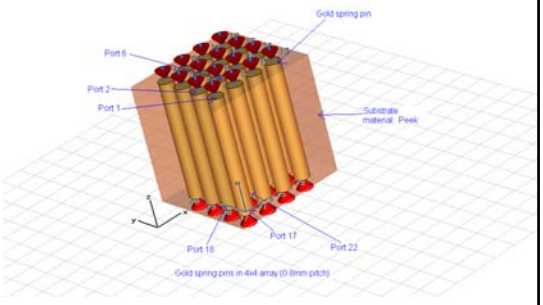


QFN Socket Adapter Return Loss

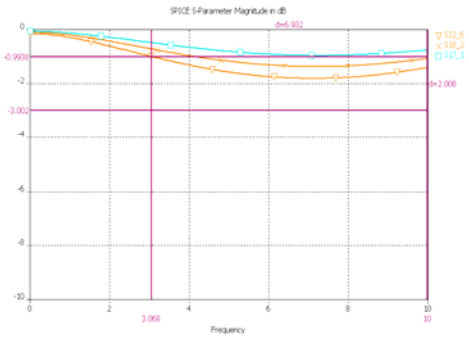
Poster #2

BGA Pogo Pin Socket

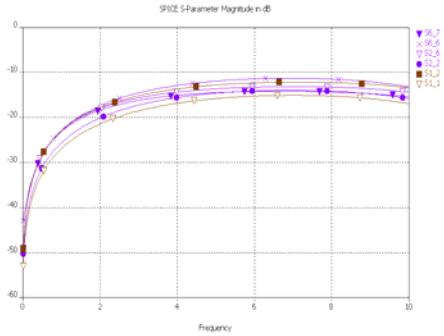
0.8mm pitch spring pin socket simulation data



Pogo Pin Contactor Model



Pogo Pin Simulated Insertion Loss



Pogo Pin Simulated Return Loss

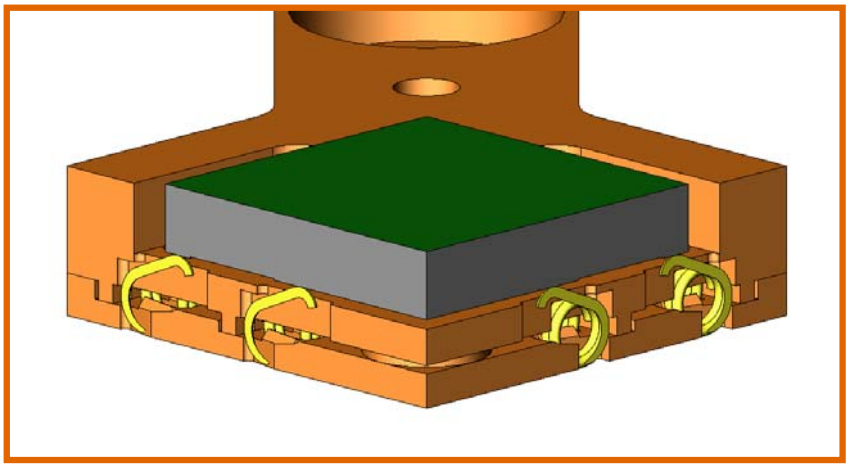
Electromagnetic simulation modeling capability has proven to be an efficient and effective means for the interconnection provider to keep pace with the rapidly changing world of high-speed microelectronic device testing, prototyping, and end-product applications. The CST™ simulation package has successfully been applied to several different socket and adapter configurations. In so doing both the accuracy and versatility of this simulation technique has been demonstrated. When coupled with the timely and cost-effective manner in which similar models may be developed, the applicability of SI simulation as a useful tool for interconnection designs of the future may also be anticipated.

BiTS 2008

ARDENT CONCEPTS, INC. Innovative Interconnect Solutions

New Solution for Chipscale RF Lead Free ATE Test

Sergio Diaz, Design Engineer



ATE Ready

Footprint Compatible

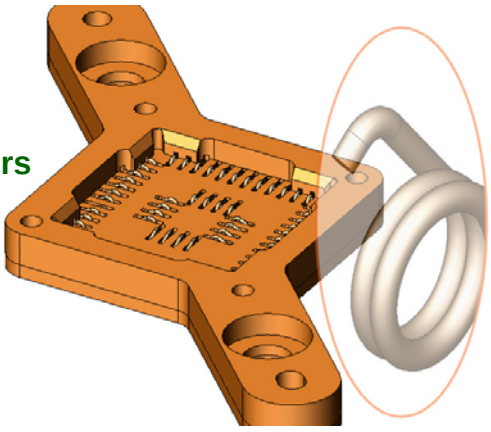
Multi-GHz Bandwidth

All Metal Contact – No Elastomers

Down to .4mm Contact Pitch

High Durability for High Volume

.95mm Test Height

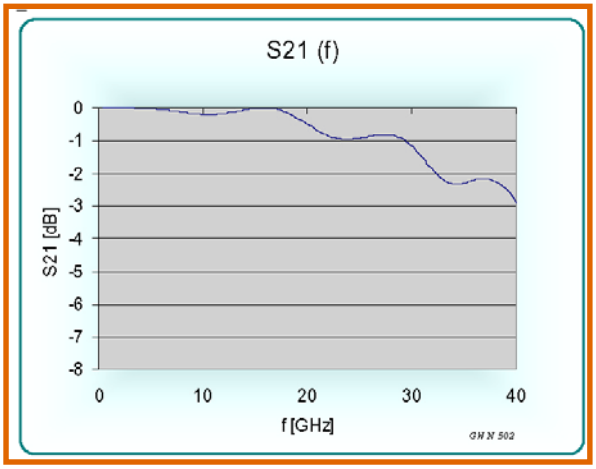


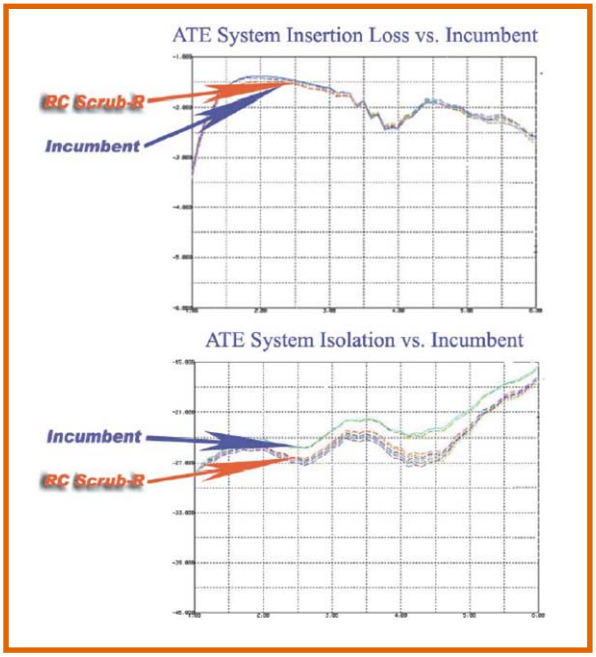
Family Contactors with Short Lead Times

Easily Replaceable Contact Sets

Poster #3

Customer Challenge - Provide a cost effective alternative to existing offset contactor solutions with comparable Insertion Loss and Isolation performance.

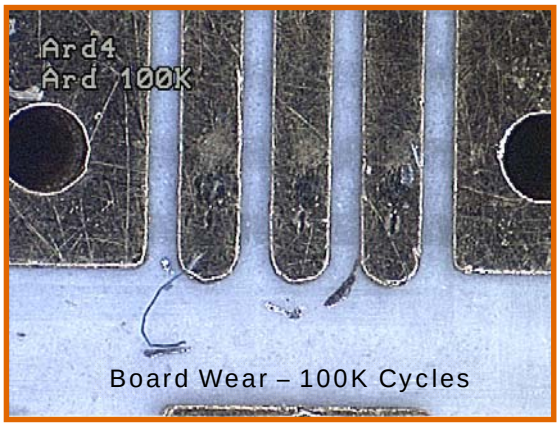


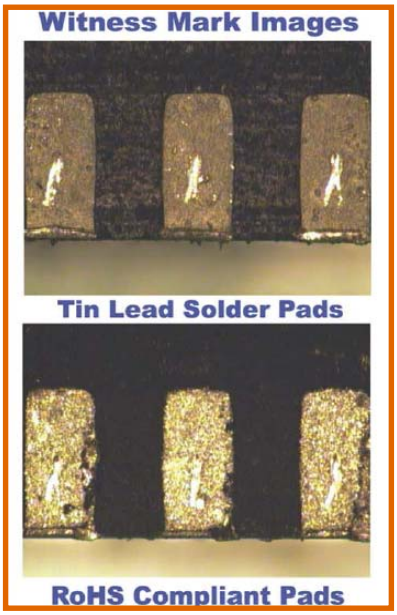


Solution
Adapt legacy RC Springprobe™ technology to offset footprint and harness AC performance of 'coil wiping' design.

Poster #3

Customer Challenge - Ensure High Cycle Life & High Reliability of Contactor Set with less board wear over extended cycles in ATE environment.





Solution
Design RC Scrub-R™ contact to provide minimum board side translation and maximum DUT side translation of contact during compression.

3/2008 New Solution for Chipscale RF Lead Free ATE Test 3

Poster #3

BiTS 2008

antares Advanced Test Technologies

1mm Length Spring Probe: Practical?
- A study of spring pin dimension limit

Jiachun Zhou (Frank), Praveen Matlapudi, Mark Murdza
Antares ATT

Outline

- Introduction
- Example of Typical Pin Dimensions
- Design Model & Methodology
- Design Calculation
- Mechanical Feature Limitations
- Pin Dimensional Limit Example
- Summary

Introduction

- Trends in semiconductor industry:
  - High frequency, Small pitch package
  - Increased current carrying capacity
  - Larger number of I/O
- Challenges to spring probes:
  - Shorter pin for high frequency
  - Smaller diameter - drives to increase length.
- Effects on contactor: shorter contactor profile.

What is the limit of pin length?

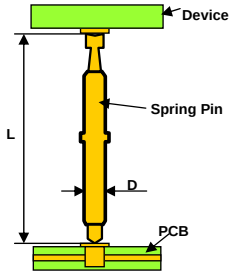


Fig. 1 Pin contact model

Objective of Study

Use typical spring pin model shown in Fig. 1 as reference to investigate impacts of variables on pin length and predict the length limit of spring pin.

Example of Typical Pin Dimensions

- **Pin designs vary from company to company. However, the dimensions of typical pins exhibit correlations with pitch, stroke and force, shown in Fig. 2.**

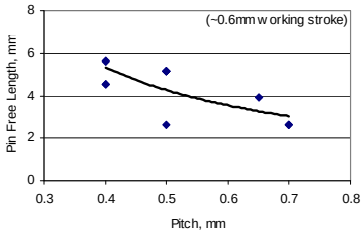


Fig. 2 Example of product pin dimensions

Design Model & Methodology

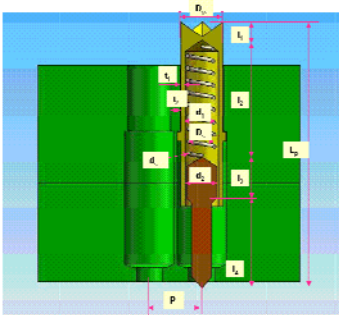


Fig. 3 Pin model & dimension symbol.

- **A calculator has been developed to generate pin dimensions based on structure in Fig. 3 as a typical pin structure.**

Pin dimensions to be determined:

Lp – spring probe total length, mm
Dp – spring probe diameter, mm.

Input variables for design calculations:

P – pitch, mm; S – spring probe working stroke, mm
F – spring force, gf

Assumptions in calculations:

- **Spring material: music wire**
- **Shell wall thickness: 0.07mm**
- **Pin diameter: 0.1mm less than pitch**
- **Spring life: >100K**

Poster #4

Resulting Calculations

- **Pitch, working stroke and spring force are major factors considered in pin design based on their roles in applications. Fig. 4~ 6 shows the impact on pin dimensions.**

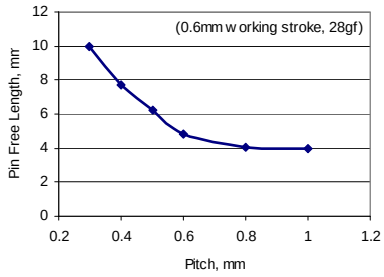


Fig. 4 Effect of pitch on pin length

- **Pin length is mainly effected by pitch, particularly those < 0.5mm pitch. The pin length will be > 6mm. (Fig. 4)**
- **Reducing pin stroke can significantly reduce overall length. Spring length, which is a function of pin stroke, plays a large roll in the resulting pin length.**
- **Impact of pin force on pin length is limited when compared to pitch and stroke. The spring dimensions are determined by barrel diameter or by pitch. Pin force affects the resulting contact resistance. Higher pin force is preferred in pin design, to reduce contact resistance.**

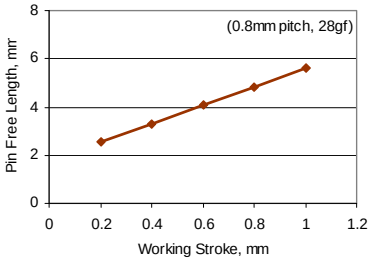


Fig. 5 Effect of working stroke on pin length

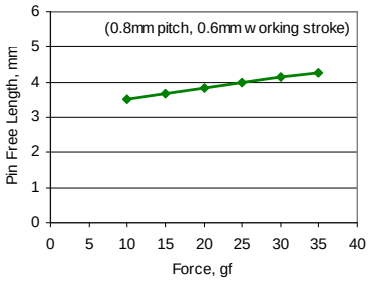


Fig. 6 Effect of force on pin length

- **Pitch, stroke, and force are primarily determined by application and performance requirements. These variables are primary drivers in the resulting structure of pin's spring. Several other mechanical features in pin design can affect pin dimensions.**

Mechanical Feature Limitation

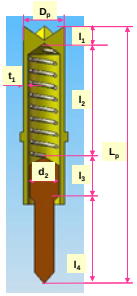


Fig. 7 Spring dimension model for factor analysis.

- **Other variables that effect overall pin length are pin tip length (l_1) and plunger bearing surface length (l_2).**
- **Fig. 8 shows function of the pin tip on pin length. However, in a crown configuration reducing the tip length results in a increase in the inclusive angle of the crown. As the crown angle increases, the crown becomes shallow and and become susceptible to debris accumulation and resulting poor performance over increased cycles. 0.45mm should be crown length limit.**

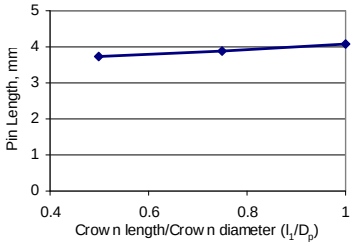


Fig. 8 Pin crown length (l_1) effect on pin length.

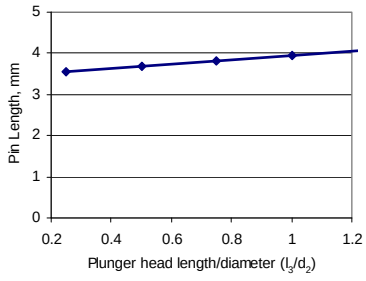


Fig. 9 Plunger head length (l_2) effect on pin length.

Poster #4

- Plunger bearing surface length affects the stability of electrical contact of plunger and barrel, but also can be a factor to spring length. Additionally, this feature is critical to target accuracy, as a larger bearing surface results in a concentric alignment between the plunger and barrel, as shown Fig. 9.
- The spring is the heart of the spring probe, as its most effect on the pin's overall performance. As a function of all of the mating variables spring durability is the resultant that must be optimized. Designed not correctly, the spring can experience early failures due to high stress levels. To maximize durability, the spring must be maintained at the longest possible length by reducing the resultant stress to minimize fatigue and fracture.
- Well known from material fatigue theory, long spring life design requires minimized permissible limiting stress that can be determined by multiplying the spring material tensile strength by the factor of spring stress limit – the smaller the resulting factor, the less permissible limiting stress applied. Fig. 10 indicates increased spring length as function of reduced factor of spring stress limit to improve spring cycle life.

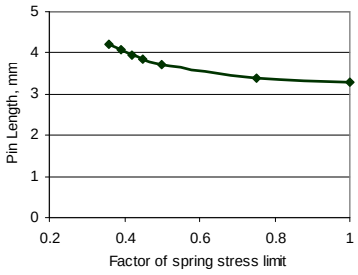


Fig. 10 Pin length and spring stress limit factor

Pin Dimensional Limit Example

- Taking the variables into account an example spring probe is calculated and the resulting pin length is shown in Fig. 11. and Fig. 12.
- To predict pin dimensional limit, the analysis uses music wire tensile strength as permissible limiting stress in spring. Obviously, higher tensile strength material than music wire can make pin shorter.
- The calculations show the spring pin length limit of ~1.6mm at pitch of >0.6mm. The length increases significantly as pitch <0.5mm or increasing working stroke. Larger spring force leads to longer pin, which becomes more at pitch<0.5mm.

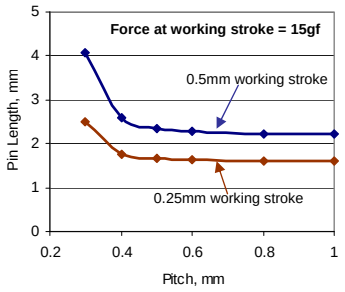


Fig. 11 Spring pin length limit vs. working stroke

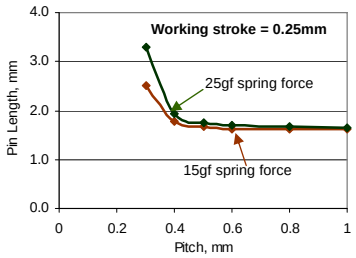


Fig. 12 Spring pin length limit vs. force

Summary:

- A multitude of variables contribute the overall dynamics and resulting performance of a spring probe.
- By leveraging knowledge of spring probes, a methodology for spring probe development was created and incorporated into a program. This program is used to as reference to assist in estimating basic spring pin dimensions. The technical parameters for pin application and structural features are included in this program.
- Two primary characteristics that effect overall performance of spring probes are overall length and spring force. Force effect the resulting contact resistance due to the integrity of interconnect at the DUT terminal, and spring length plays to the resulting durability .
- Maintaining the basic function of a spring probe with music wire, taking the spring permissible limit stress into account for the spring configuration, the spring pin length limit is ~ 1.6mm with pitch >0.6mm. The limits on pin length are significantly constrained as pitch falls < 0.5mm where smaller diameters dictate the need for a longer spring with enough working stroke, in order to maximize durability.

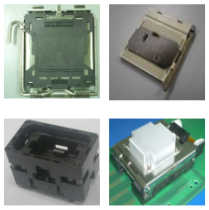
BiTS 2008

Challenges of Surface Mounted Test Sockets

Dr. Shih-Wei Hsiao and Andrew Gattuso

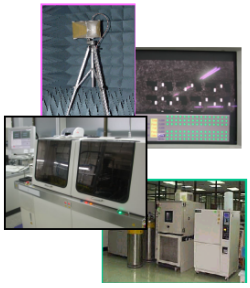
Background

Product



In House Manufacturing

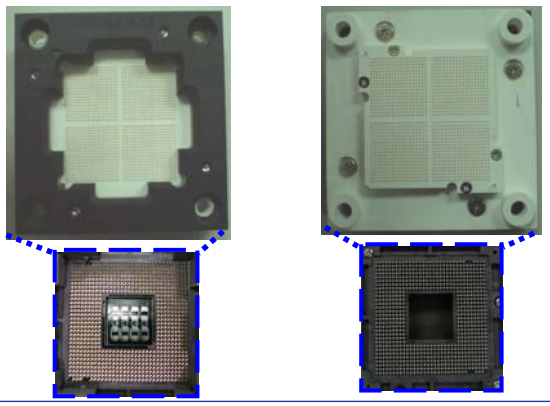
QA System & Labs



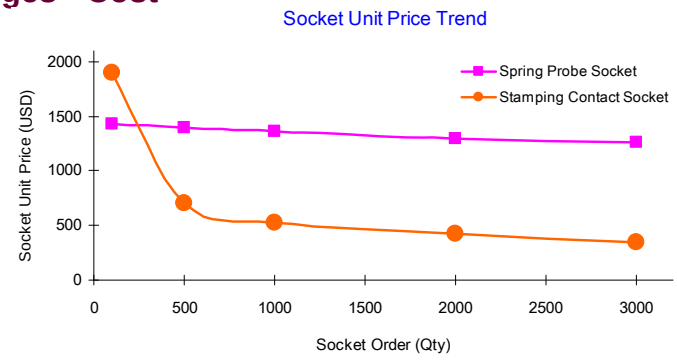
Challenges - Space

CMT LGA Test Socket

SMT LGA Test Socket

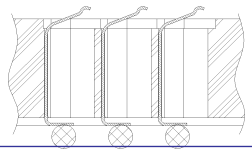


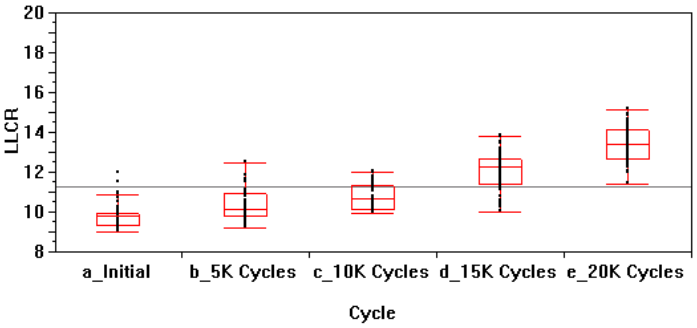
Challenges - Cost



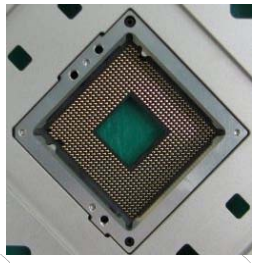
Poster #5

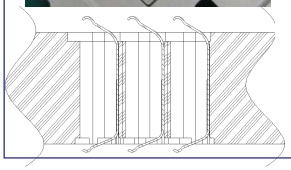
Challenges – Resistance -SMT LGA Test Socket

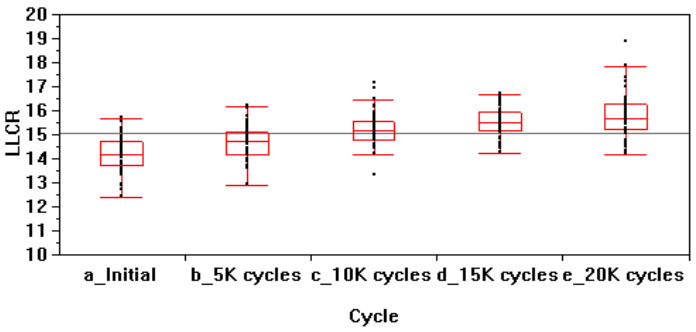




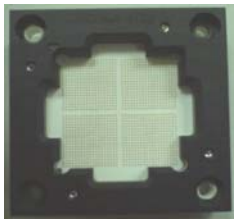
Challenges – Resistance - CMT LGA Test Socket

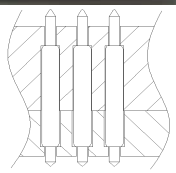


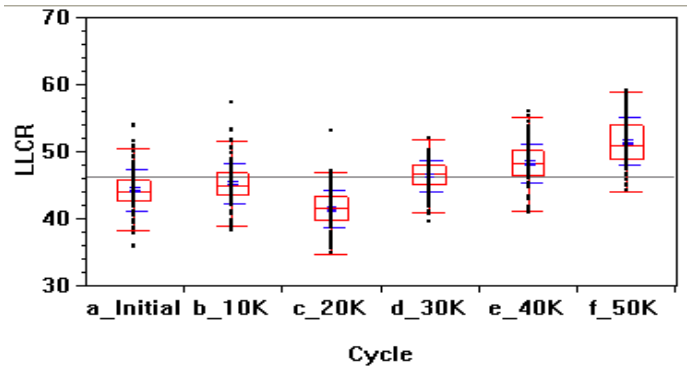




Challenges – Resistance - Spring Probe LGA Test Socket



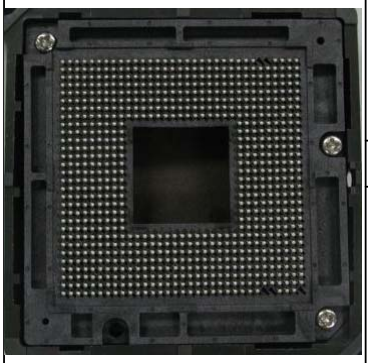




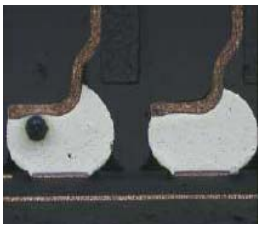
3/2008 Challenges of Surface Mounted Test Sockets 2

Poster #5

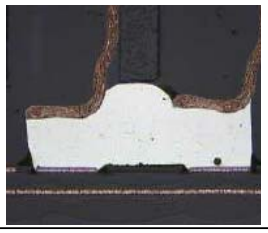
Challenges - SMT Failure Modes



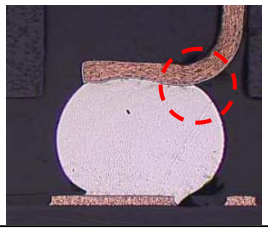
Open Joint



Void

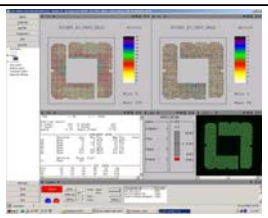


Solder Bridge



Poor Wetting

Inspection Equipment (Ball True Position/ Coplanarity)

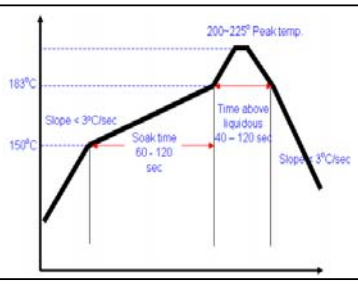


ICOS (100% On-line Inspection)

QV-pro

SMT Conditions

Reflow Oven



Optimal Reflow Profile

Process	SMT Process CTF
Screen Print	Solder Paste
	Stencil Thickness
	Stencil Diameter
	Paster Alignment
PnP	Placement Nozzle
	Nozzle Pick Surface
	Speed
	Placement Sequence
	Placement Alignment
Reflow	Belt Speed

Process Factors

Poster #5