
2nd Annual
BiTS
CHINA 中国
September 13, 2016
Session 2
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Session 2

Frank Zhou

Session Chair

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Socket Technology

"Study of Probe Pin Internal Resistance"

Takuto Yoshida - Test Tooling Solutions Group

"Monte Carlo Analysis for PoP Alignment"

DeXian (Frank) Liu - Smiths Connectors

"Conductive Elastomer vs Spring Probe: Performance & Application"

Jiachun (Frank) Zhou - Smiths Connectors

"Do Socket and Kits Design Matter for Die Cracking?"

Yuanjun Shi - TwinSolution Technology

BiTS 2016 China Burn-in & Test Strategies Workshop

Session 2
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Session Chair

BiTS China

Socket Technology

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施元军, 上海韬盛电子科技股份有限公司

Conductive Elastomer vs. Spring Probe
- Performance & Applications

Dr. Jiachun Zhou (Frank)
Smiths Connectors

BiTS China Workshop
Suzhou
September 13, 2016

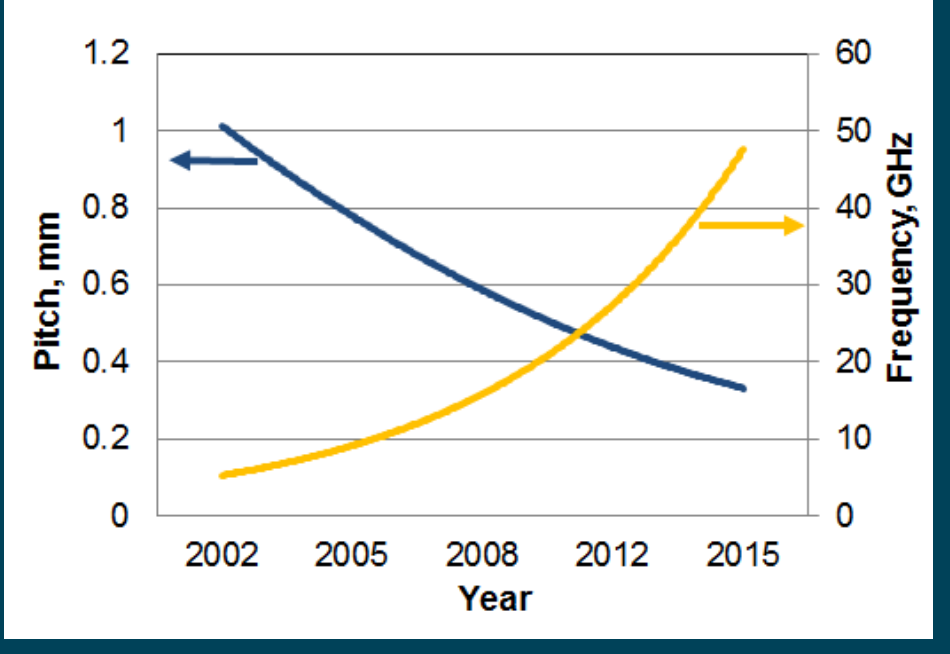
Contents

- Why Conductive Elastomer or Spring Pin?
- Structures & Contact Basics
- Performance of Two Types Contactors
- Application & Cleaning
- Summary

Why Elastomer or Spring Probe?

Semiconductor Chip Development

- High frequency
- Small pitch

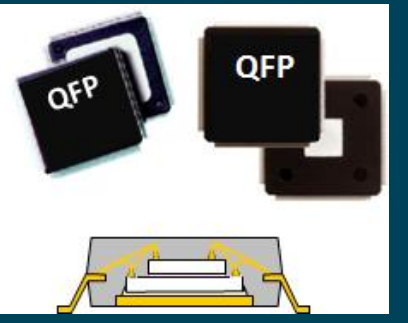


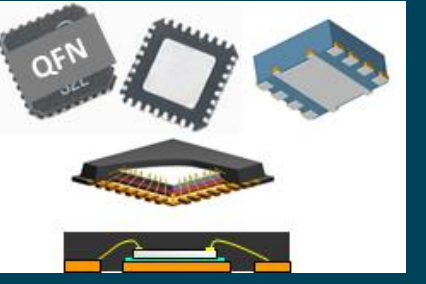
Conductive Elastomer vs. Spring Probe

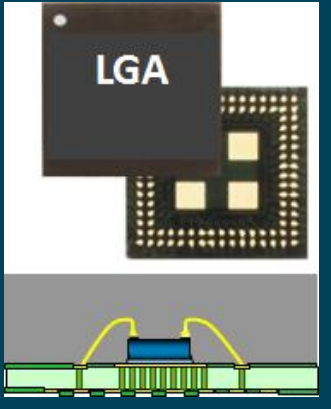
Why Elastomer or Spring Probe?

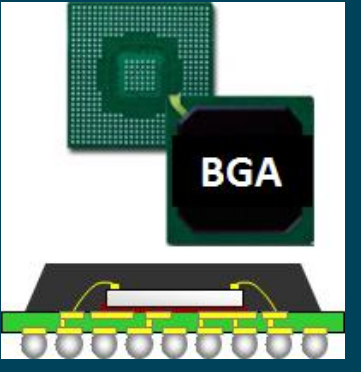
Chip Package Evolution

- Small size
- Growths in package types
- Package structure changes
- 2.5/3D package



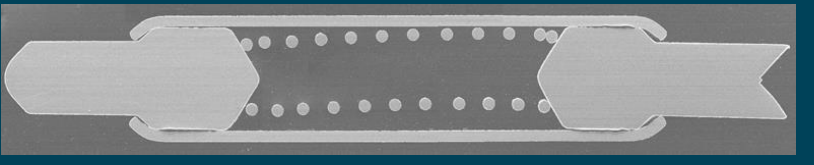


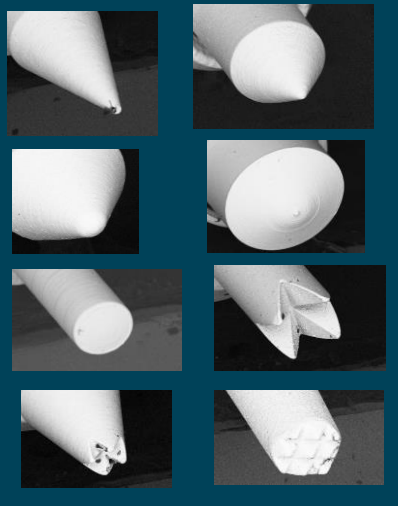




Basics Structure
(Spring Probes)

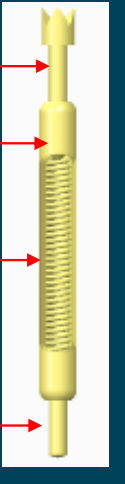
- Top plunger
- Barrel
- Spring
- Bottom plunger





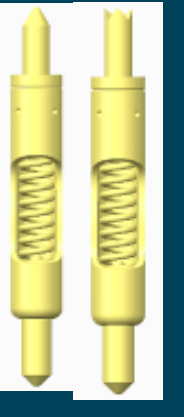
Spring Probe Structure Evolution

4 pieces
2 moving plungers



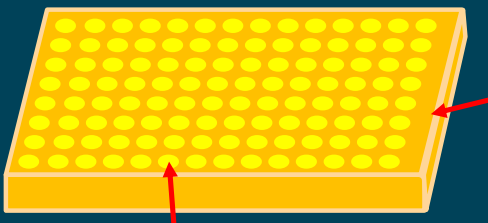
3 pieces
1 moving plunger

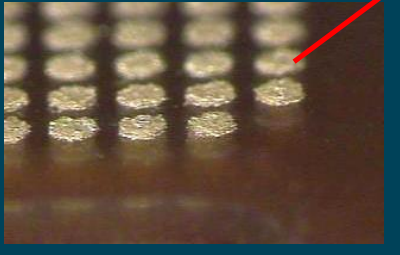
4 pieces
1 moving plunger



Basics Structure
(Conductive Elastomer)

- Elastomer sheet
- Conductive elements



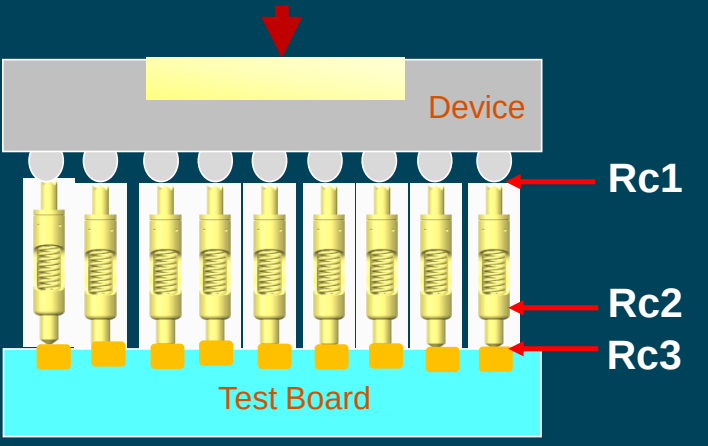

Metal Powder Column


Metal Wire

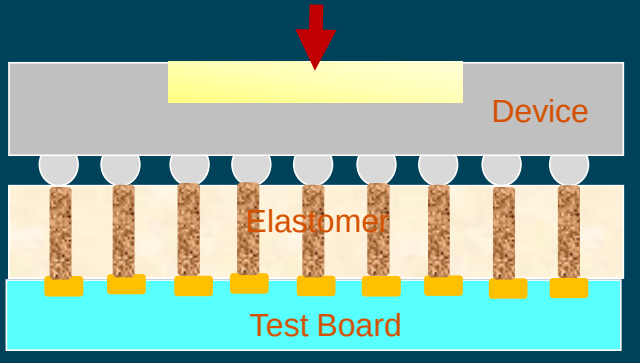

Metal Particle Chain

Contact Model Comparison

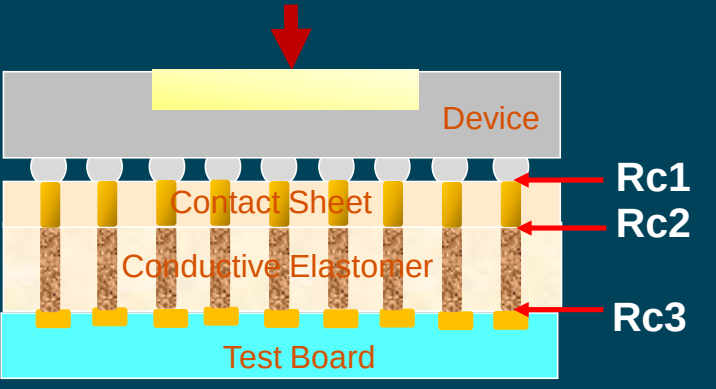
- Rc: Contact Resistance
- Contact points with high or unstable resistance



Contact on Elastomer

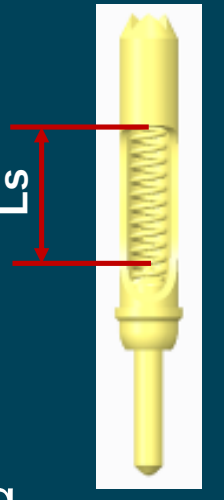


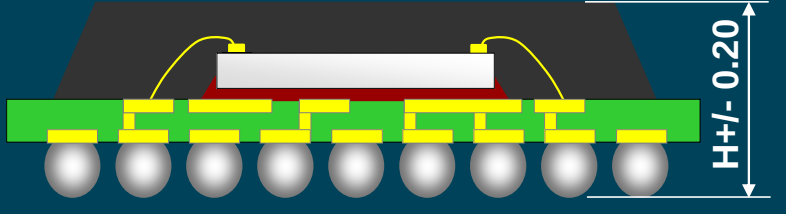
Contact on Contact Sheet

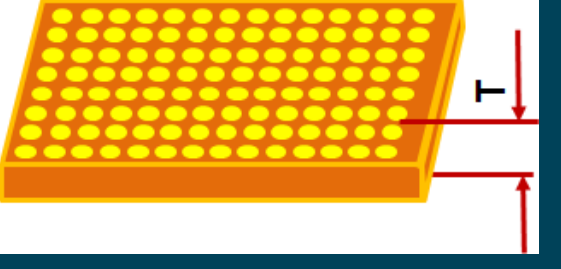


Performance: Compliance

- Contactor compliance covers the total geometrical tolerances in package, test board and socket.
- Spring probe compliance relies on spring design: ~ 25% of spring free length, working compliance 0.3~0.8mm.
- Elastomer compliances relies on elastomer material, 10~25% elastomer thickness, working compliance 0.1~0.3mm.



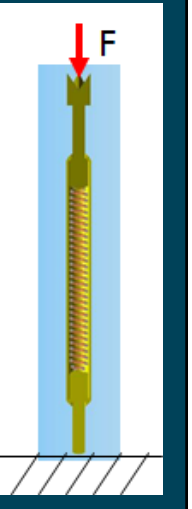




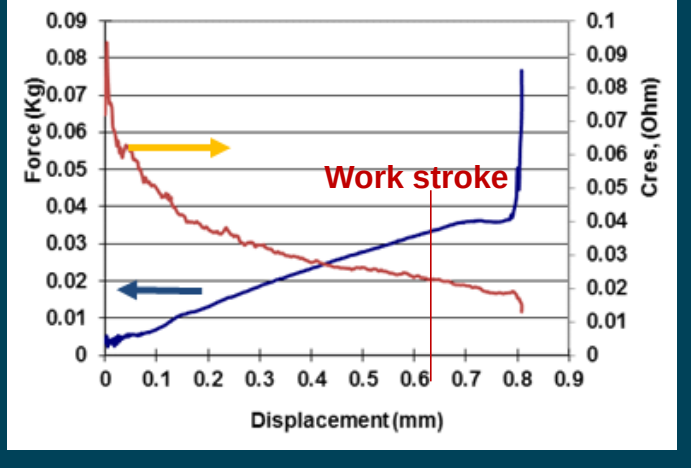
Conductive Elastomer vs. Spring Probe

Performance: Cres & Force

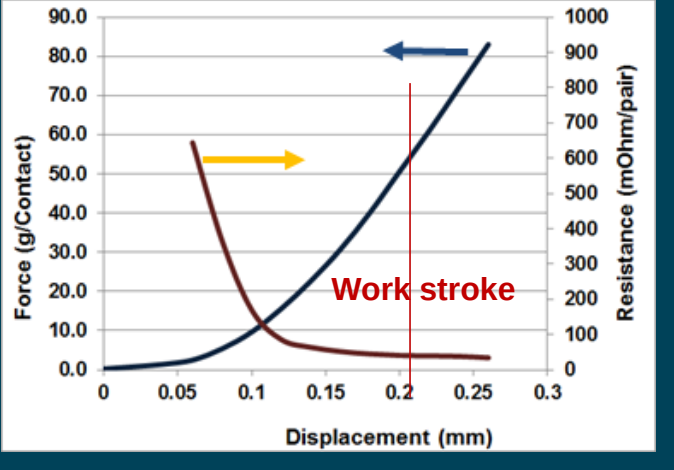
- Elastomer: lower Cres, higher force
- Spring probe: slight higher Cres, low force
- Spring probe: preload on test board side



FDR: Spring Probe



FDR: Conductive Elastomer



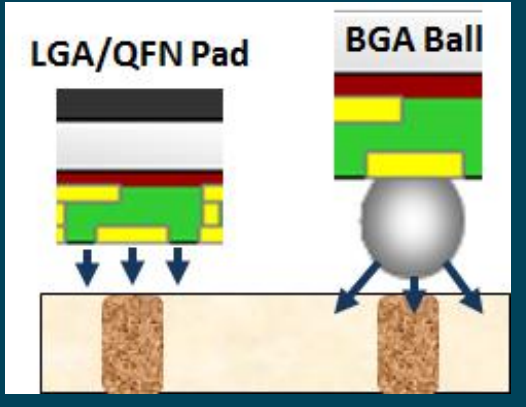
FDR: Force-Deflection-Resistance

Performance: Cres & Force

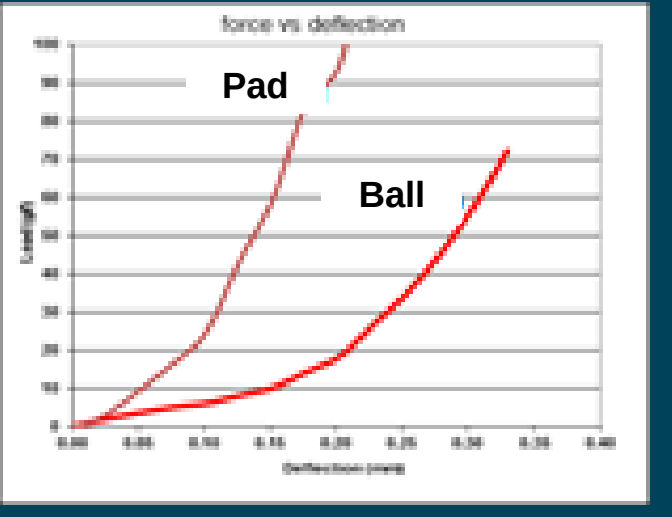
Impacts of package type on elastomer force

- Flat surface, such as LGA/QFN pads, generates higher force when placed directly on elastomer.
- Ball structure, such as BGA, has much less force due to x-side force.

Force vs Package Type



Force vs. Displacement



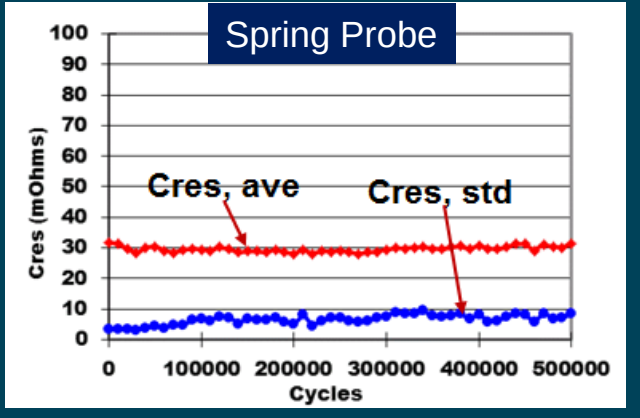
Performance: Cres & Life

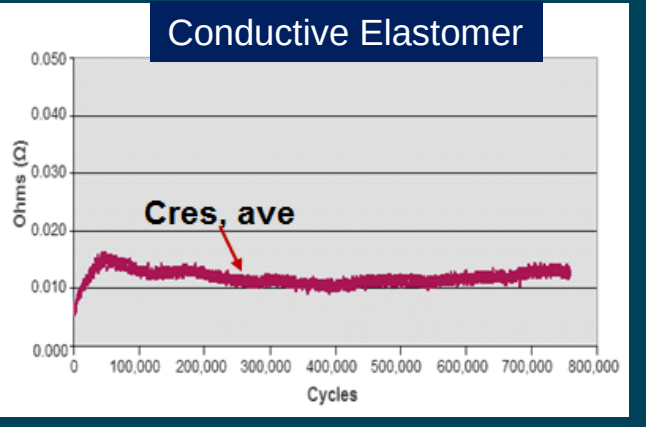
Spring probe:

- Average Cres ~ 30mOhm, Std Cres ~ 10mOhm
- Up to 500K cycles based on test environment

Conductive elastomer:

- Average Cres ~ 10mOhm
- >100K cycles based on test environment



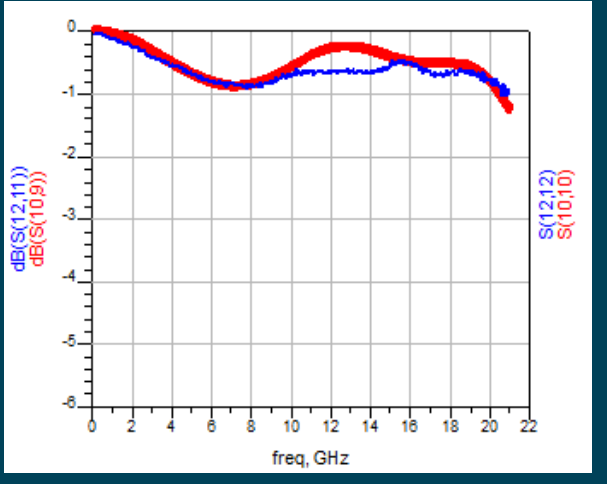


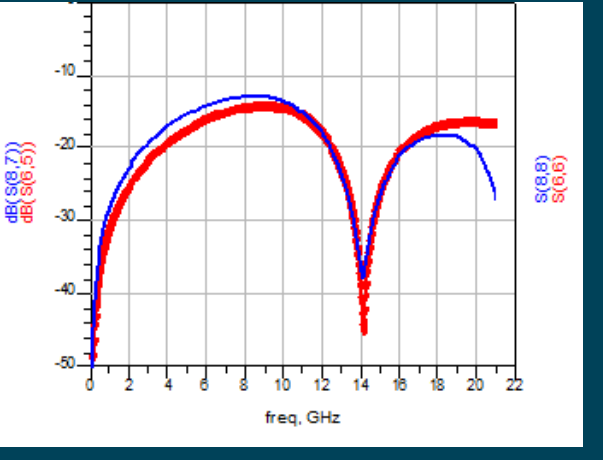
Std: Standard Deviation

Performance: Signal Integrity

Spring probe

- 0.5mm pitch
- Better than -1dB S21 Insertion Loss, 20 GHz
- Better than -12dB S11 Return Loss, 20 GHz
- Lab measured data with test height 3mm



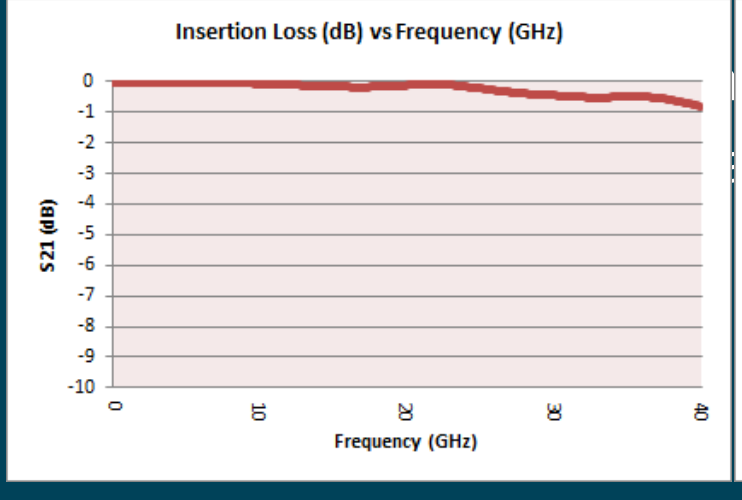


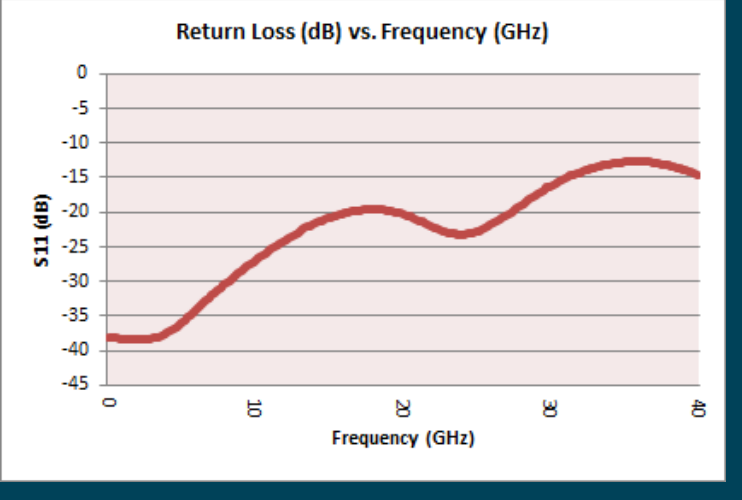
Conductive Elastomer vs. Spring Probe

Performance: Signal Integrity

Conductive elastomer

- 0.5 mm pitch
- Better than -1dB S21 Insertion Loss, 40 GHz
- Better than -12dB S11 Return Loss, 40 GHz
- Lab measured data with test height ~ 1mm.



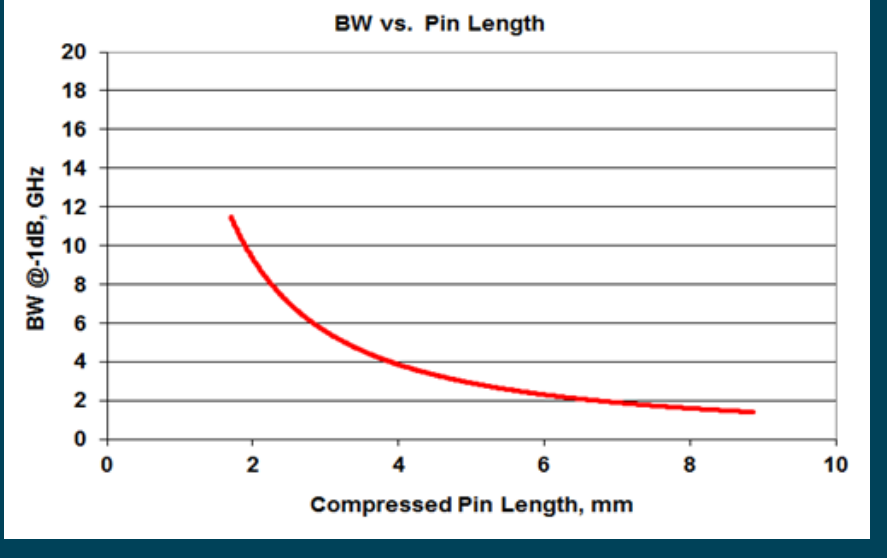


Conductive Elastomer vs. Spring Probe

Performance: Signal Integrity

General guidelines

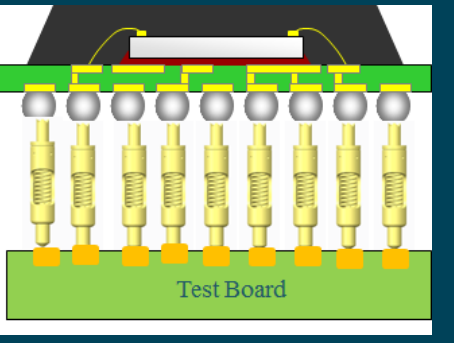
- Shorter contactors with higher bandwidth
- Impedance matches impact signal integrity
- Other factors, such as socket material, pin diameter, pitch, and structure impact SI significantly

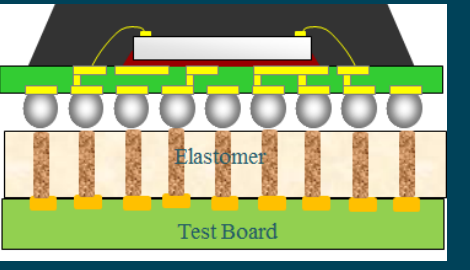


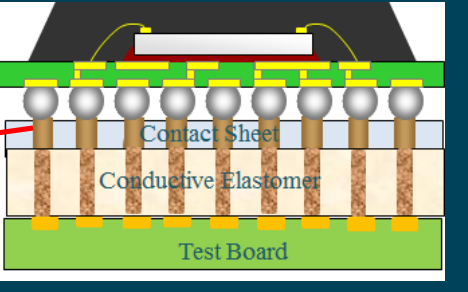
Conductive Elastomer vs. Spring Probe

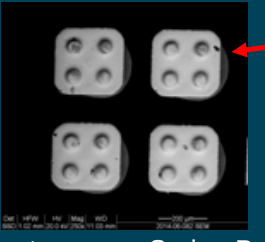
Application: BGA Packages

- 4 point crown has better contact.
- Direct contact to elastomer causes contamination quickly.
- More compliance in spring probe better for BGA.
- Proper BGA package range <40mm for high volume testing with elastomer contactors.
- Elastomer with contact sheet to avoid contamination on elastomer.





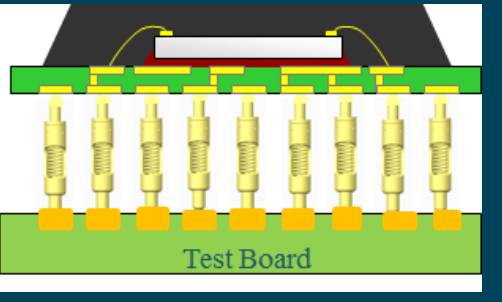


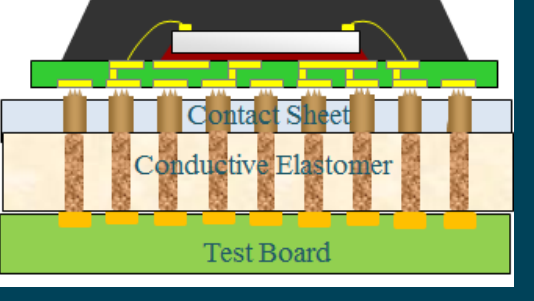


Conductive Elastomer vs. Spring Probe

Application: LGA/QFN Packages

- Elastomer higher force, less Cres
- Recessed pad limitation on elastomer contactors
- Contact sheet on elastomer better for recessed pads
- Contact sheet has short tips for more reliable contact





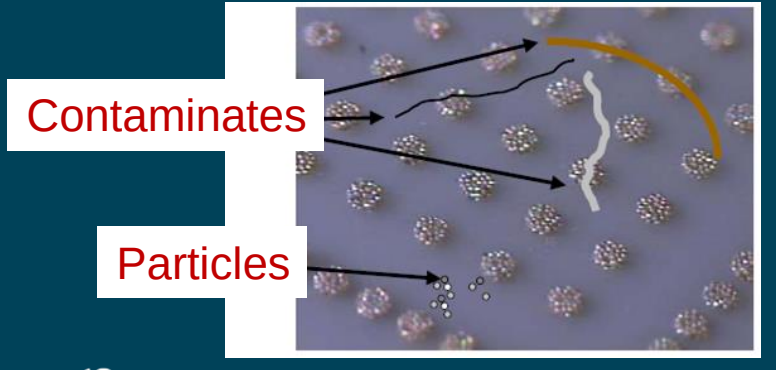
Cleaning: Spring Probe

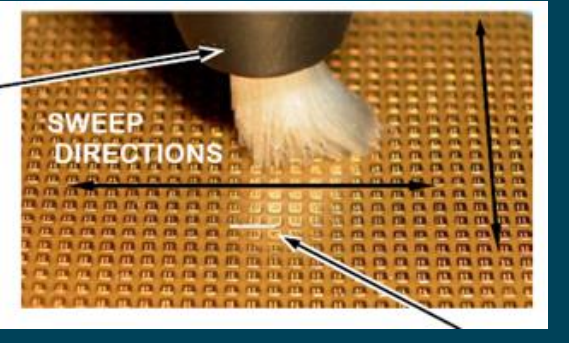
- Soft bristle brush with compressed air in proper pressure ~ 30psi, online
- Wash loose pins in ultra sonic bath (methanol, acetone)
- Laser cleaning pins in socket
- Cleaning pads to clean pins in socket

Conductive Elastomer vs. Spring Probe

Cleaning: Elastomer

- Soft nylon brush and compressed air for on/off line cleaning elastomer – gentle & careful operations
- No chemicals for cleaning elastomer
- Brush & compressed air to clean contact sheet
- Chemicals (alcohol, methanol) used to clean contact sheet. Dry it before re-using
- Keep proper directions when brushing





Performance Comparison

Items	Spring Probe	Conductive Elastomer
Test Height, mm	2.5 ~ 5	0.75 ~ 1.5
Compliance, mm	> 0.3	0.1 ~ 0.3
Cres, mOhm	~40	~ 10
Force, gf	30	30 ~ 70
Cycling Life, K	500	100 (up to test environment)
Signal Integrity Bandwidth, GHz	15	40
Cleaning	Multi methods	Brush + Air (mostly)

* All these data are for reference since the actual values rely on various factors, such as material, structure, test environments, etc.

Summary

- Spring probe as widely used contactor has advantages of more compliance, low force, easier maintenance.
- Conductive elastomer has much better signal integrity performance with shorter electric path.
- Contact sheet applied in elastomer contactor effectively avoids contamination on elastomer surface and extends the life of elastomer.
- Proper selection of contactor based on technical specifications of the application.