
2nd Annual
BiTS
TM
CHINA 中国
September 13, 2016
Session 2
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Frank Zhou
Session Chair

BiTS China

Socket Technology

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BiTS 2016 China
Burn-in & Test Strategies Workshop

Study of Probe Pin Internal Resistance

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Test Tooling Solutions Group

BiTS China Workshop
Suzhou
September 13, 2016

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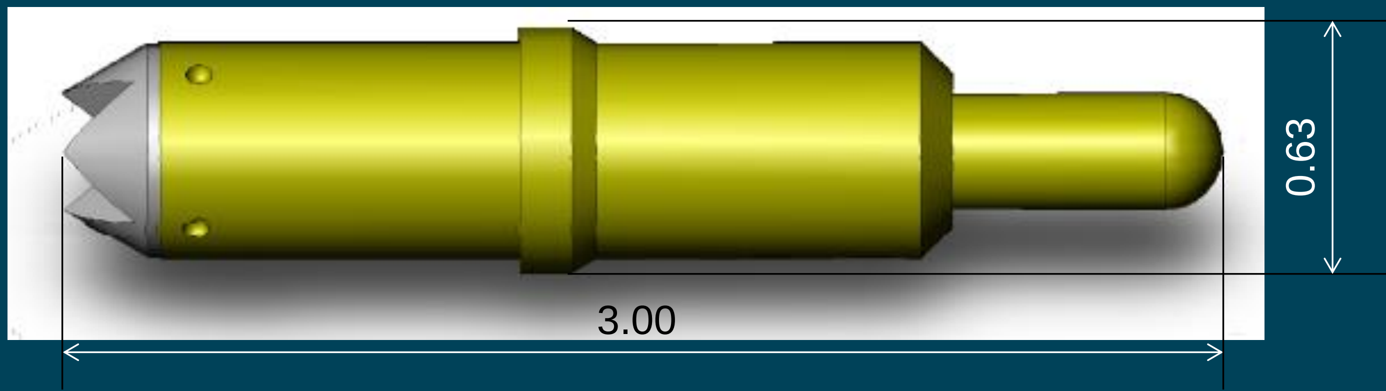
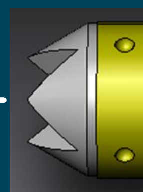
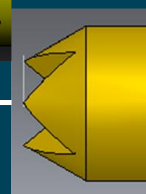
CRES Comparison by Pin Design



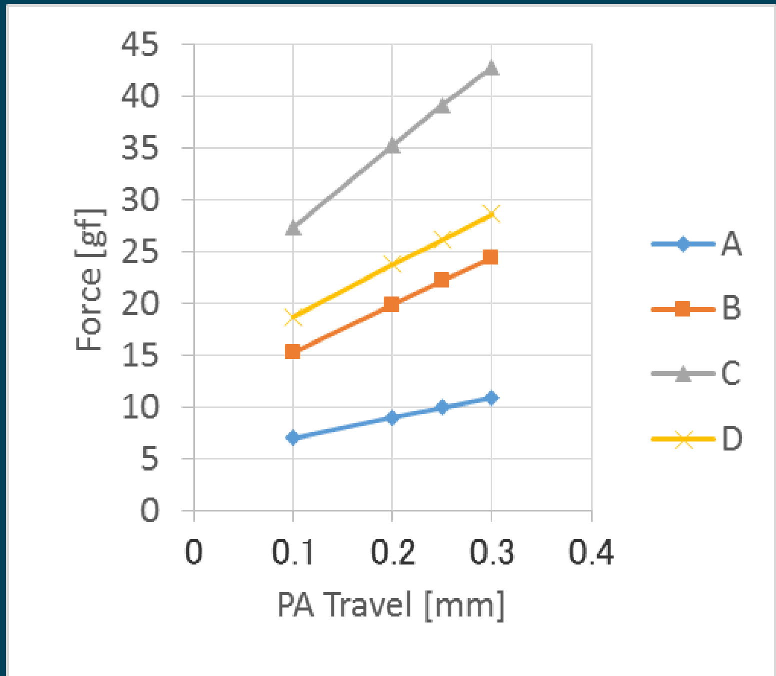
- Pin Pitch: 0.8mm
- Test Height: 2.5mm
- Pin Design
  - "A": 10gf, 4-point crimped PA
  - "B": 25gf, 4-point crimped PA
  - "C": 42gf, 4-point crimped PA
  - "D": 28gf, Combined PA and Barrel

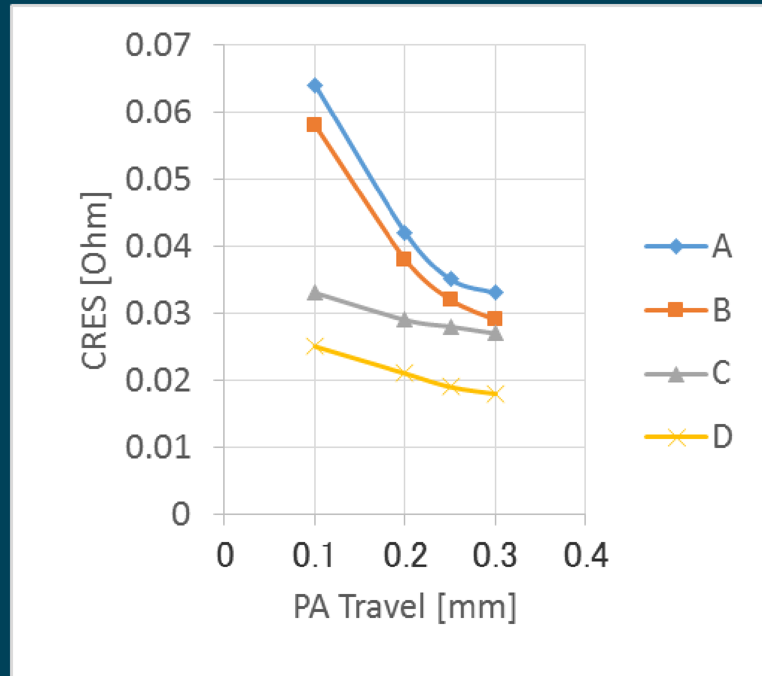




PA: Plunger A (device side)

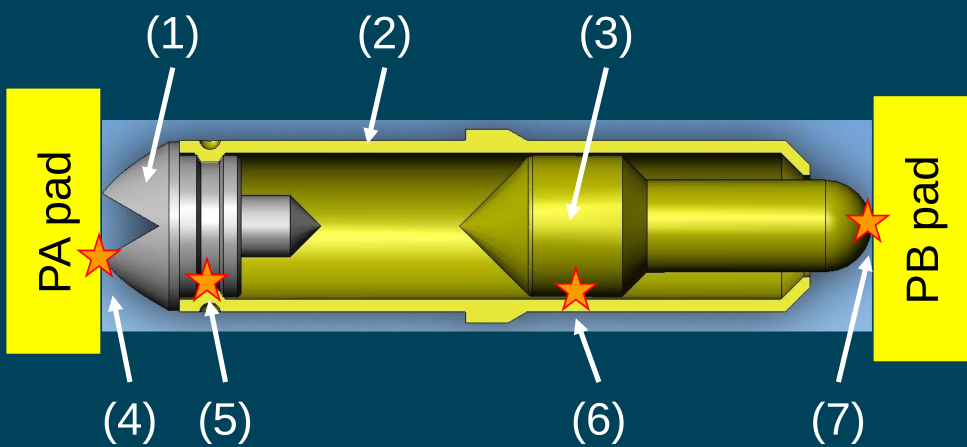
CRES Comparison by Pin Design





- Higher pin force is lower CRES pin
- Combined PA and Barrel pin (“D”) is the lowest CRES pin
- CRES differ by pin design (18 mOhm to 33 mOhm)

CRES Composition in a Probe Pin



Note
PA: Plunger A (device side)
PB: Plunger B (PCB side)
BR: Barrel
Spring is removed from the drawing because it is no contribution to CRES path

(1) PA material electrical resistance
(2) BR material electrical resistance
(3) PB material electrical resistance

} Material resistance

(4) PA pad to PA contact resistance
(5) PA to BR contact resistance
(6) BR to PB contact resistance
(7) PB to PB pad contact resistance

} Contact resistance

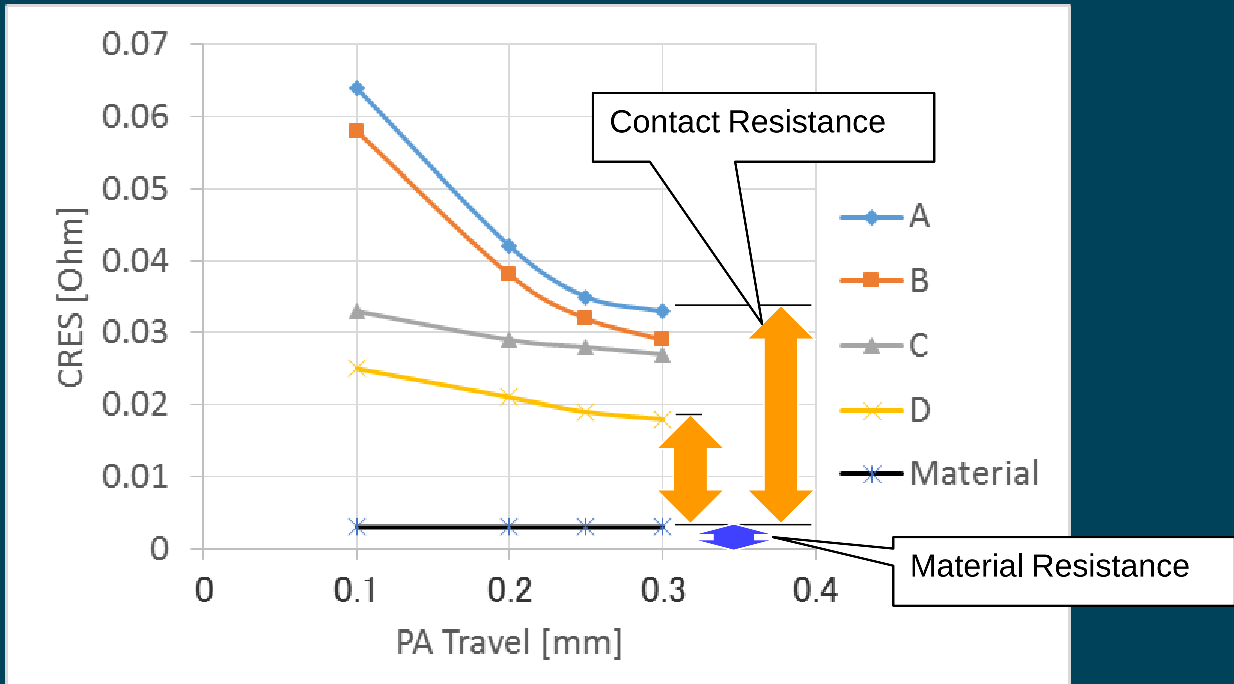
Material Resistance

$$R = \rho \frac{L}{A}$$

- R: Electrical resistance (measured in ohms, Ω)
- ρ: Electrical resistivity (measured in ohm·meters, Ω·m)
- L: Length of material (measured in meters, m)
- A: Cross-sectional area of material (measured in square meters, m^2)

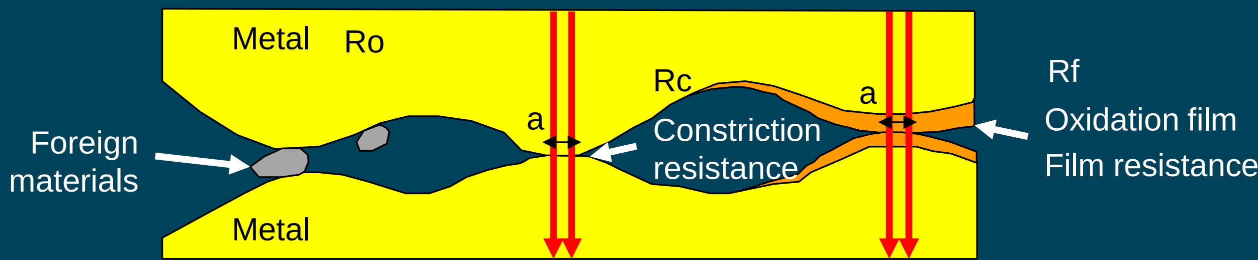
Total Material Resistance ⇨ R = 0.003 Ohm

Material Resistance Contribution



- Material resistance contribution is only 9% to 17%
- Contact resistance is main player for pin CRES

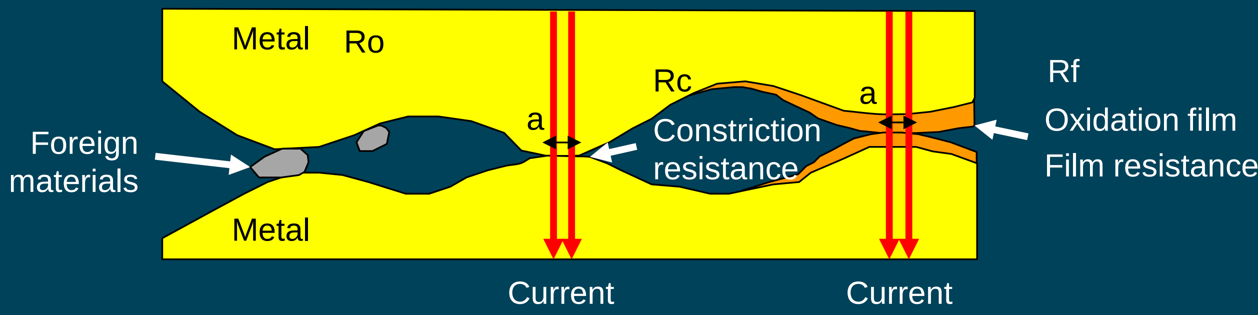
Contact Resistance



$$R = Rc + Rf + Ro$$

- *R*: Electrical resistance (measured in ohms, Ω)
- *Rc*: Constriction resistance (measured in ohms, Ω)
- *Rf*: Film resistance (measured in ohms, Ω)
- *Ro*: Metal specific resistance (measured in ohms, Ω)

Contact Resistance



$$Rc = \frac{\rho}{2a} \qquad Rf = \frac{\sigma d}{\pi a^2}$$

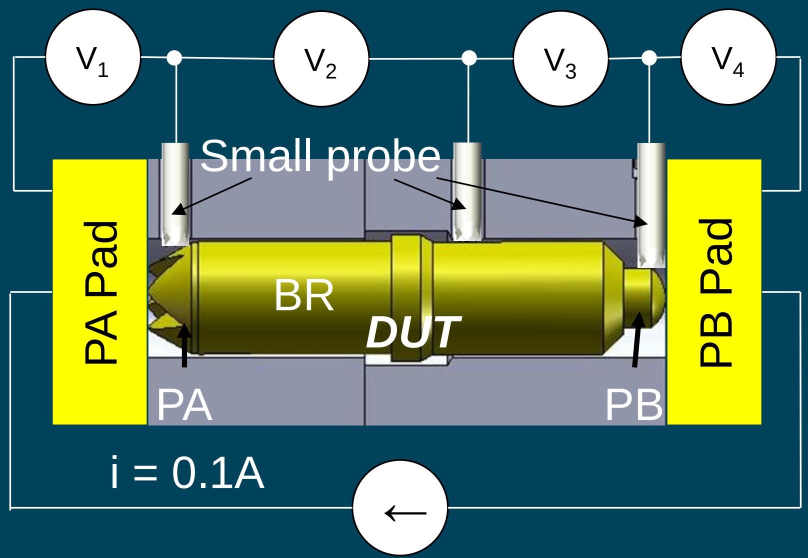
- *ρ: Electrical resistivity (measured in ohm·meters, Ω·m)*
- *a*: True contact area diameter (measured in meters, m)
- *σ*: Film electrical resistivity *(measured in ohm·meters, Ω·m)*
- *d*: Film thickness (measured in meters, m)

Contact Resistance

- Constriction resistance contributor
  - Contact area shape
  - Contact force
  - Plating material and thickness
  - Hardness
  - Surface roughness
- Film resistance contributor
  - Material
  - Thickness

Individual CRES Measurement

4-wire measurement method

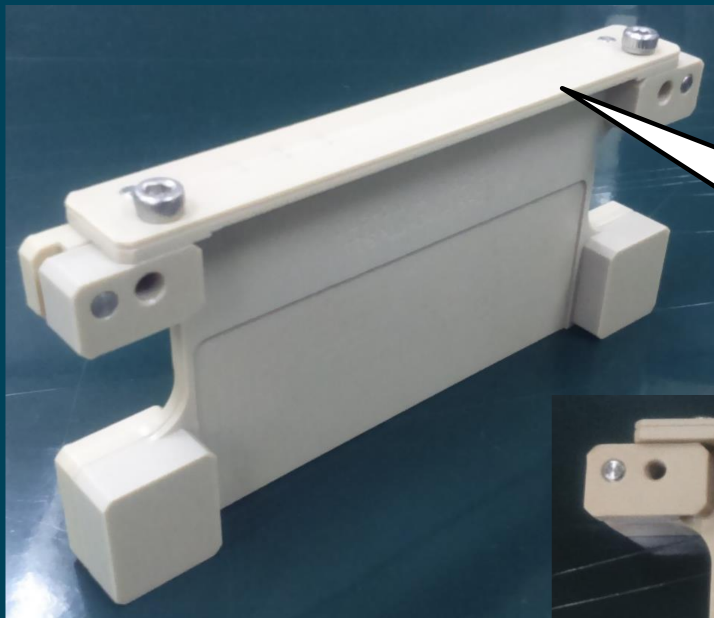


- Source Meter Keithley 2400
- Digital Multimeter Yokogawa 7555

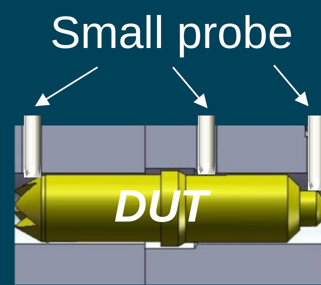
- PA Pad and PB Pad compress DUT
- 3 small probes to contact DUT surface

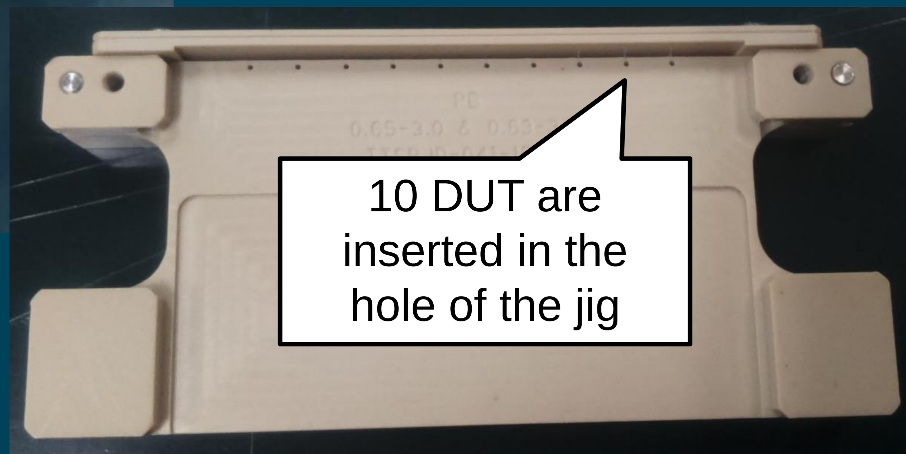
- $R_{(PA\ Pad\text{-}PA)} = V_1/0.1$
- $R_{(PA\text{-}BR)} = V_2/0.1$
- $R_{(BR\text{-}PB)} = V_3/0.1$
- $R_{(PB\text{-}PB\ Pad)} = V_4/0.1$

Individual CRES Measurement Jig

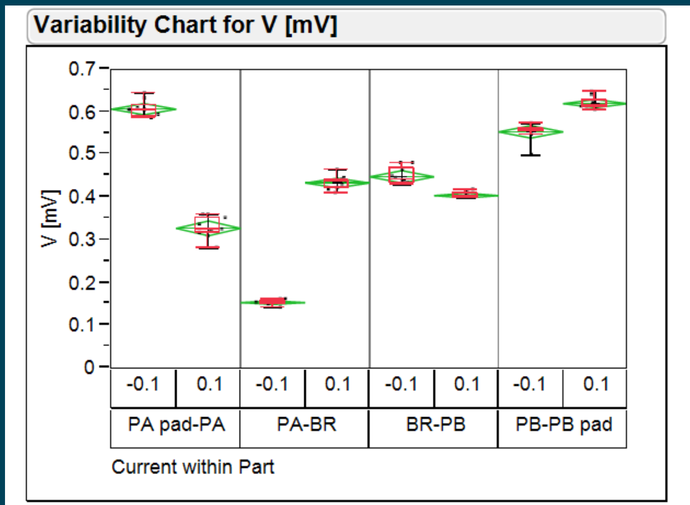


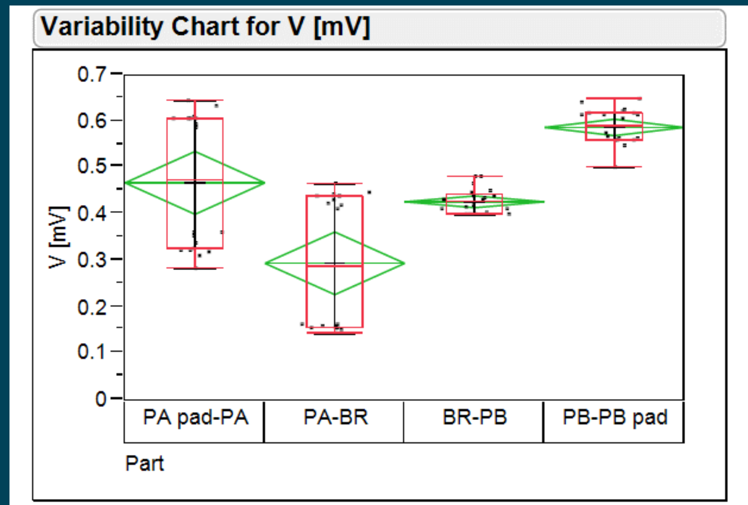
3 small probes are inserted for each DUT





Individual CRES Measurement

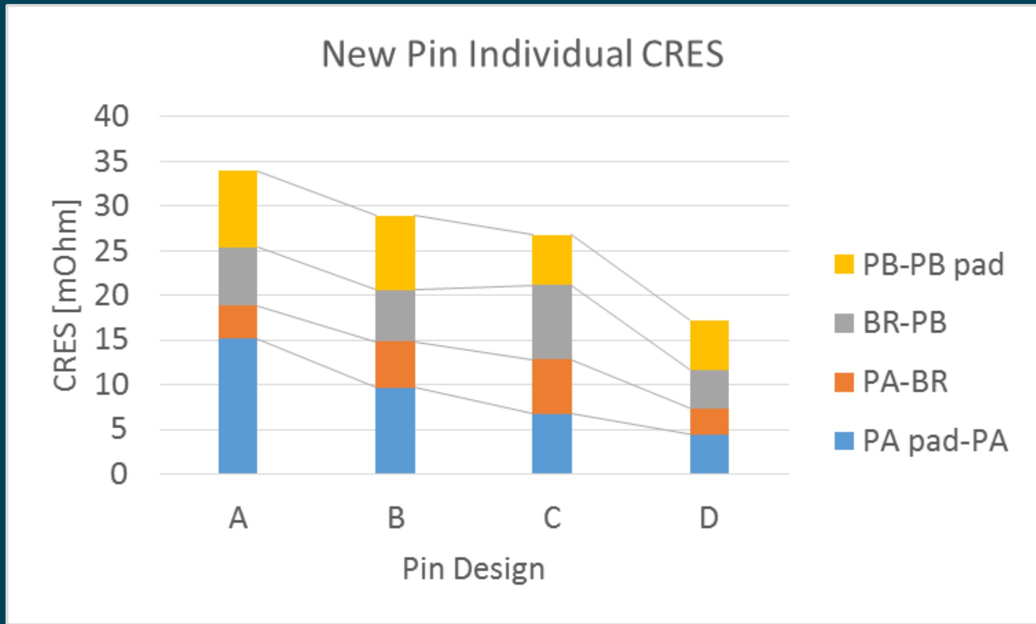




Measurement example

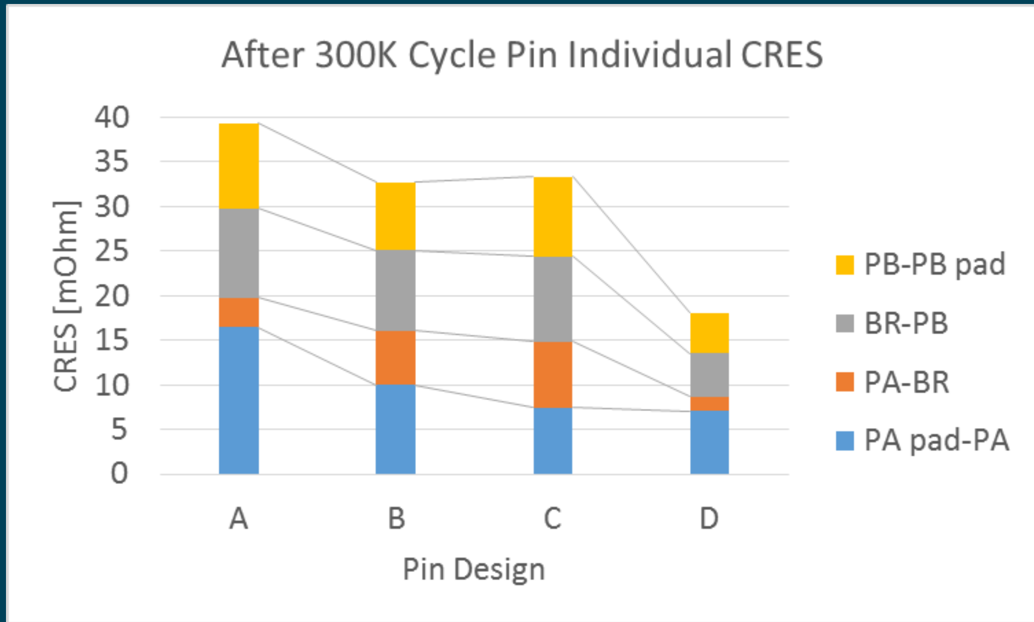
- Measure 10 times for each session with current of +0.1A and -0.1A by considering thermoelectric effect
- Measured voltage was different by thermoelectric effect
- Average voltage value for resistance calculation

New Pin Individual CRES



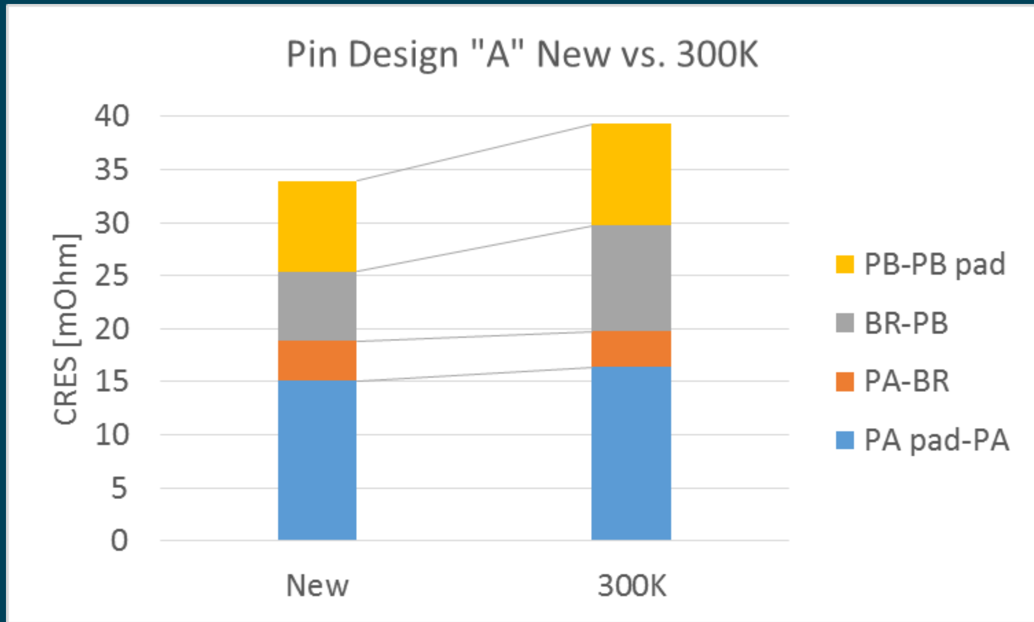
- Pin Design “A” (10gf), “B” (25gf), “C” (42gf), “D” Combined PA and BR
- Spring force is most to contact resistance of PA pad – PA, secondary for PB – PB pad
- Combined PA and BR design for “D” design improve contact resistance of PA – BR

After 300K Cycle Individual CRES



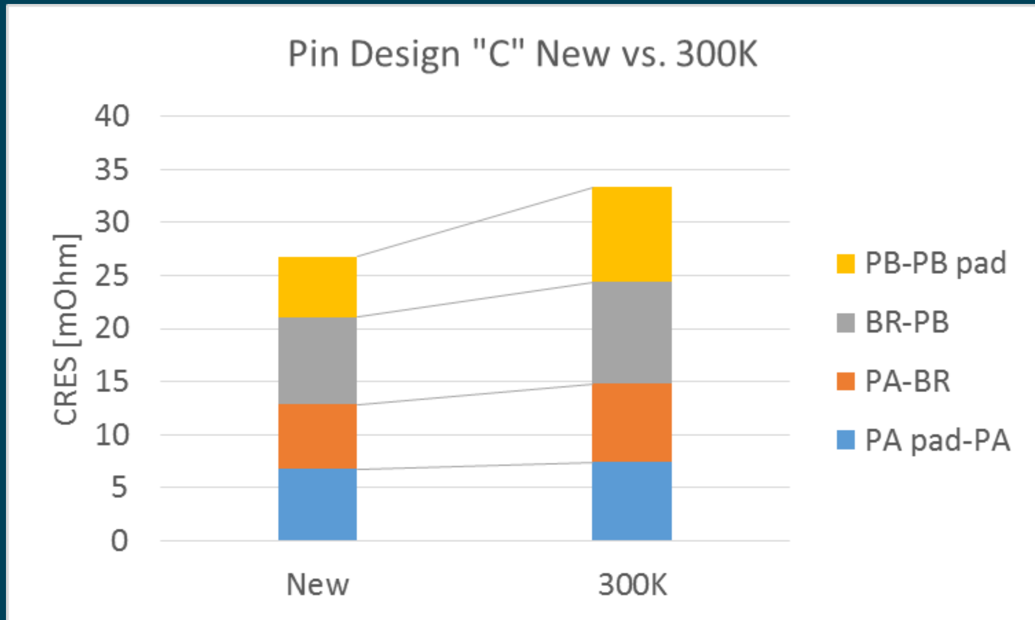
- Pin Design “A” (10gf), “B” (25gf), “C” (42gf), “D” (28gf) Combined PA and Barrel
- Cycle effect mainly impact to contact resistance of BR – PB
- Secondary impact to contact resistance of PB – PB pad

Pin Design "A" New vs. 300K



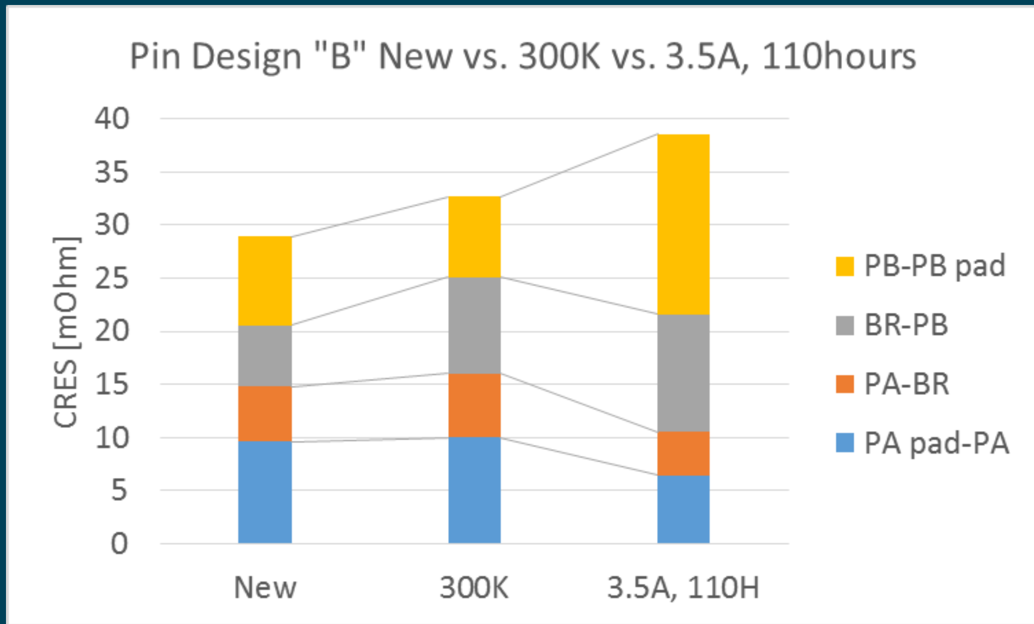
- 300K cycle test effect mainly impact to contact resistance of BR – PB
- Secondary impact to contact resistance of PA pad – PA

Pin Design "C" New vs. 300K



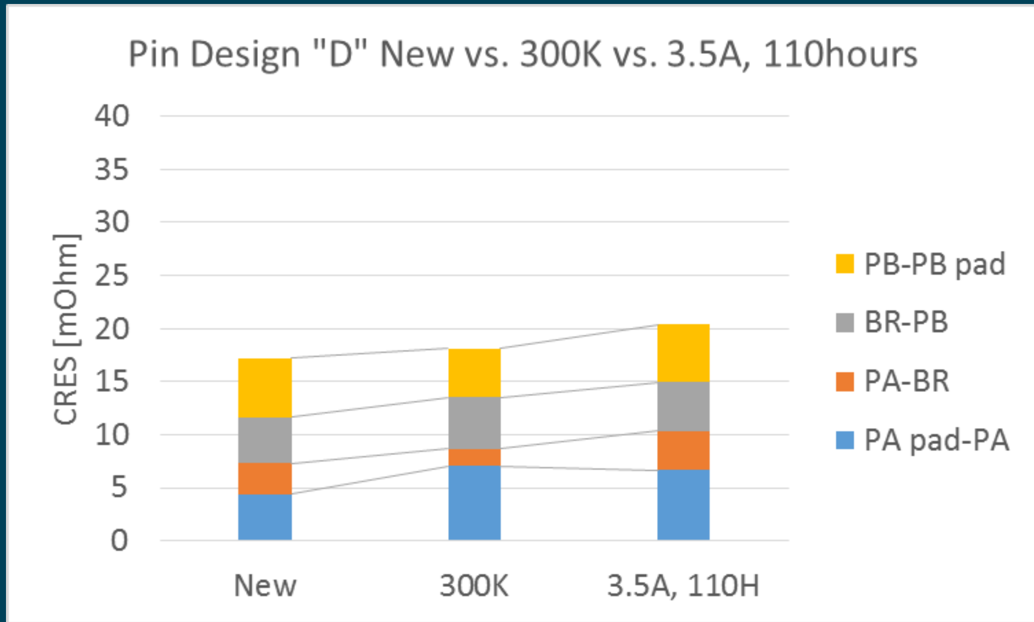
- 300K cycle test effect mainly impact to contact resistance of PB – PB pad
- Secondary impact to contact resistance of PA – BR

Pin Design "B" New vs. 300K vs. 3.5A 110hours



- Current effect mainly impact to contact resistance of PB – PB pad
- Secondary impact to contact resistance of BR – PB

Pin Design "D" New vs. 300K vs. 3.5A 110hours



- Current effect is smaller than Pin Design "B"
- Low temperature rise by current seems good for pin stability (Low CRES provide low heat (temperature rise))

Conclusion

- Understand CRES Composition in a Probe Pin
- Probe Pin CRES main player is contact resistance
- We can measure each contact resistance by using 4-wire measurement method
- Higher pin force effective to reduce contact resistance of PA pad – PA
- 300K cycle test impact to contact resistance of BR – PB (BR internal surface roughness and PB base shape seems big change)
- 3.5A 110hours test impact to contact resistance of PB – PB pad
- We feedback the probe pin design by result of individual CRES data