SW Test Workshop
Semiconductor Wafer Test Workshop

Cleaning Material Evaluations on Advanced MEMS Cantilever and Vertical Technologies

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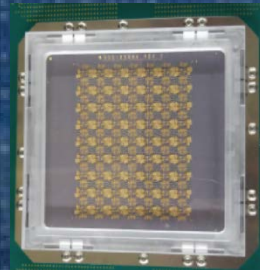
Agenda

- **Overview**
- **CRES Evaluations**
  - MEMS Cantilever Material Conversion
  - MEMS Vertical Spring Recipe Optimization
- **Cost Savings**
- **Summary of Findings**

Wait…What's That Mean?

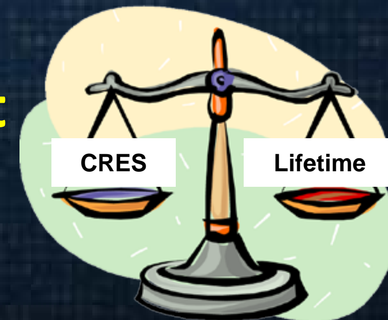
- MEMS: Microelectromechanical Systems
- CRES: Contact Resistance

Overview

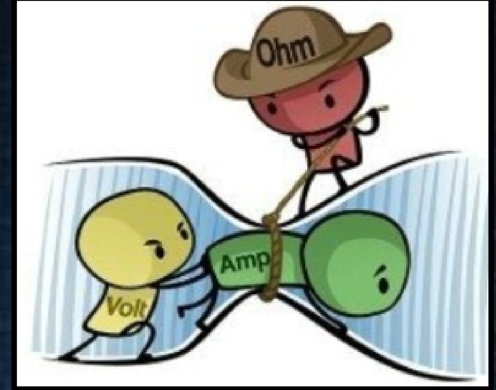
- **Automotive = Quality + Reliability**
  - Automotive requirements pushes probe to expand test temperature ranges, driving more test insertions & higher multisite
- **Advancements in Probe Card Technology and Probe Process are Necessary to keep up with Automotive Demand**
  - Probe card Complexity  so does Cost

>100 Sites

- **Maintenance of Probe Card becomes Critical to Maximizing the Investment**
  - Cleaning is required to control Contact Resistance (CRES)
  - Online probe card cleaning reduces Tip Length/Lifetime
  - Cleaning material and methods become critical to protecting the investment



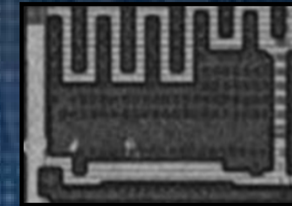
Let’s Talk Resistance



- **Contact Resistance (CRES) is Critical to Probe**
  - Occurs as probe tip and bond pad come in contact
- **Main Factors to Influence Contact Resistance**
  - Contamination on probe tip ex: debris or oxides
  - Probe tip contact surface size, texture (roughness) and probe force
  - Probing temperature affects oxidation rate and scrub size
- **Lateral Movement of Probe Scrub Breaks Through Oxide on Bond Pad Surface**
  - Cantilever and vertical probes scrub
  - Scrubbing action produces contaminants/debris

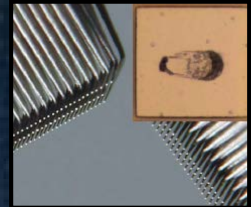
Metals Influence Amount of Scrub Debris

- **Metallurgies of bond pads change how probe needle scrubs**
  - Softer Bond pad = more scrub debris
  - Harder Bond pad = less scrub debris
- **Contact Resistance impacted by scrub**
  - Debris on probe prevents optimal contact between probe needle and pad



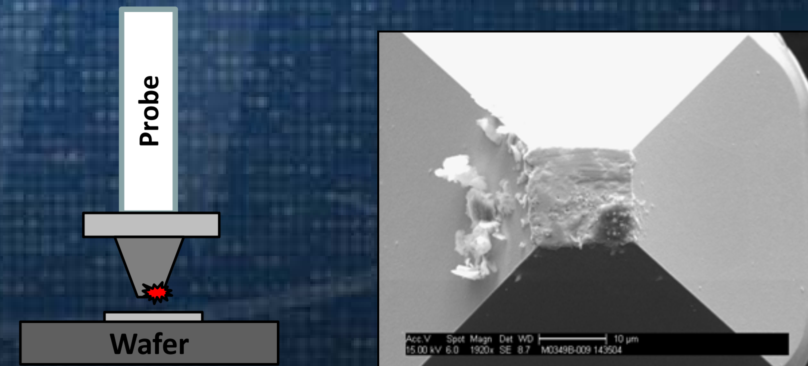
BOAC Pad (NiPd)

Vertical on Al Pad



Cantilever on Al Pad

Clean Probe Tip



Debris on/around Probe Tip

Types of Online Cleaning Materials

- **Lapping film**
  - Sandpaper type material
  - Removes contaminants from probe contact surface
- **Polyurethane Foam Material**
  - Spongy type material
  - Allows vertical probe to penetrate surface, keeping probe radius shape
- **Polymer Based Material**
  - Collects contaminates from probe tip but not abrasive
  - Extends life but will not remove all contaminants

Cleaning Materials

- In this presentation, we will focus on Advanced MEMS Cantilever and Vertical springs and how optimizing online cleaning recipes/materials maximizes lifetime/performance

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MEMS Cantilever Cleaning Material Conversion

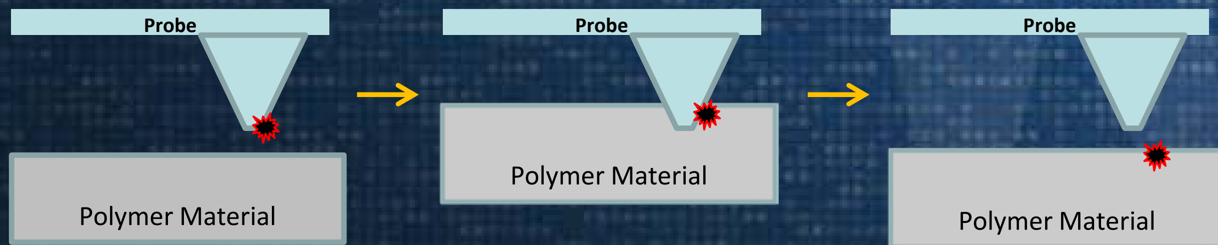
- MEMS Cantilever Spring evaluated is FormFactor's T11 probe on T11 probe solution applied used on high volume/multisite device where CRES stability is critical
- T11 probe cards introduced to TI using polymer based cleaning material
- This evaluation will consider replacing polymer based material with a lapping film

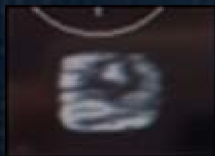
Different Strokes for Different Folks

Polymer Material

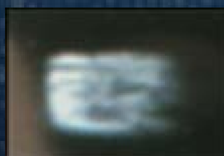
- Allows Probe to Penetrates Surface Collecting Debris

Cleaning Process





Probe with Debris

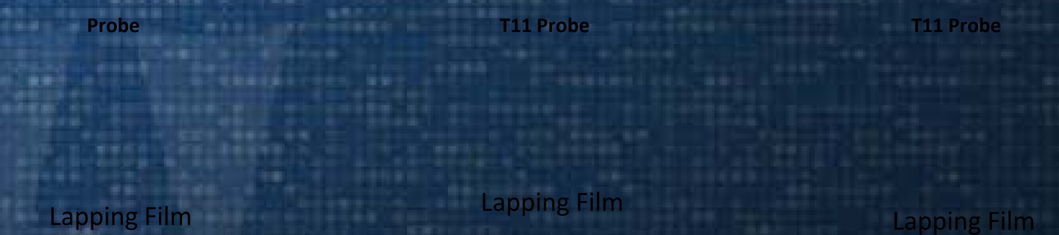


Probe After Clean

Lapping Film

- Probe Slides Across Surface Scraping Away Debris

Cleaning Process



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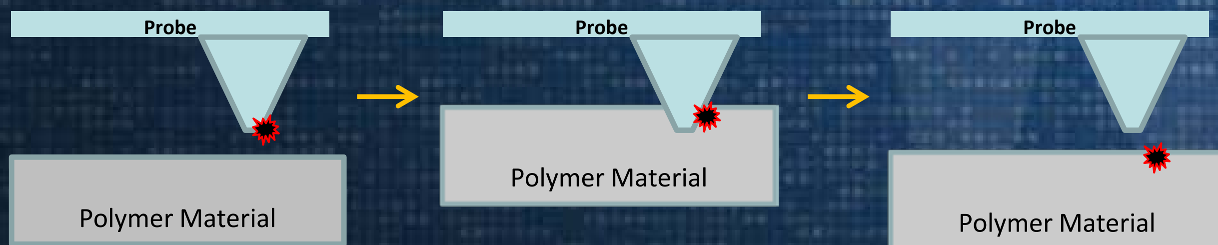

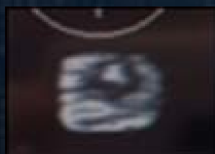

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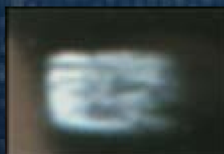

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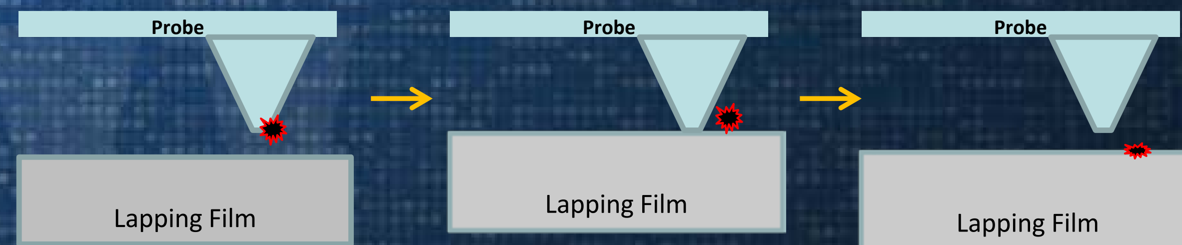
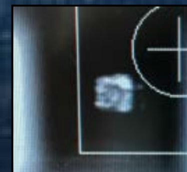




Probe with Debris

Probe After Clean

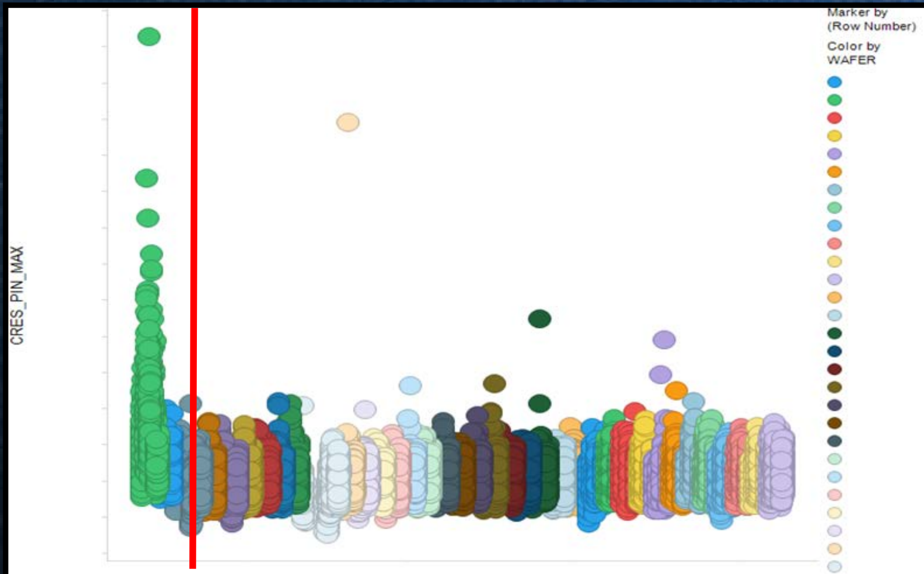
How does CRES Compare?

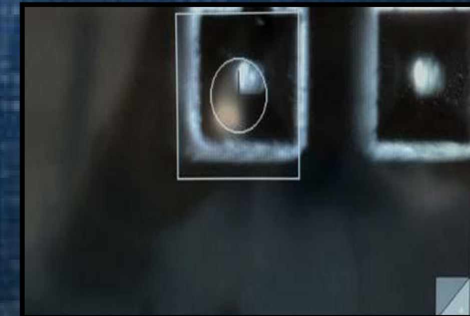
- **Demo mode probing on blank Al wafer**
  - Media A = Polymer Material (Baseline)
  - Media B = Lapping Film (Test Case)
- **Test Case shows tighter control**
  - CRESMax statically improved

	Test Case	Baseline
Count	3357	3374
Median	7.42109	8.06793
Outliers	81	282
StdDev	0.629018	4.14127

How does Device CRES Compare?

- **Use Lapping Film (Test Case) to Probe One Lot**
  - Switched from baseline Polymer to test case lapping at red line
- **CRESMax in Control Throughout Lot**
- **Minimal Wear to Probe Tip**

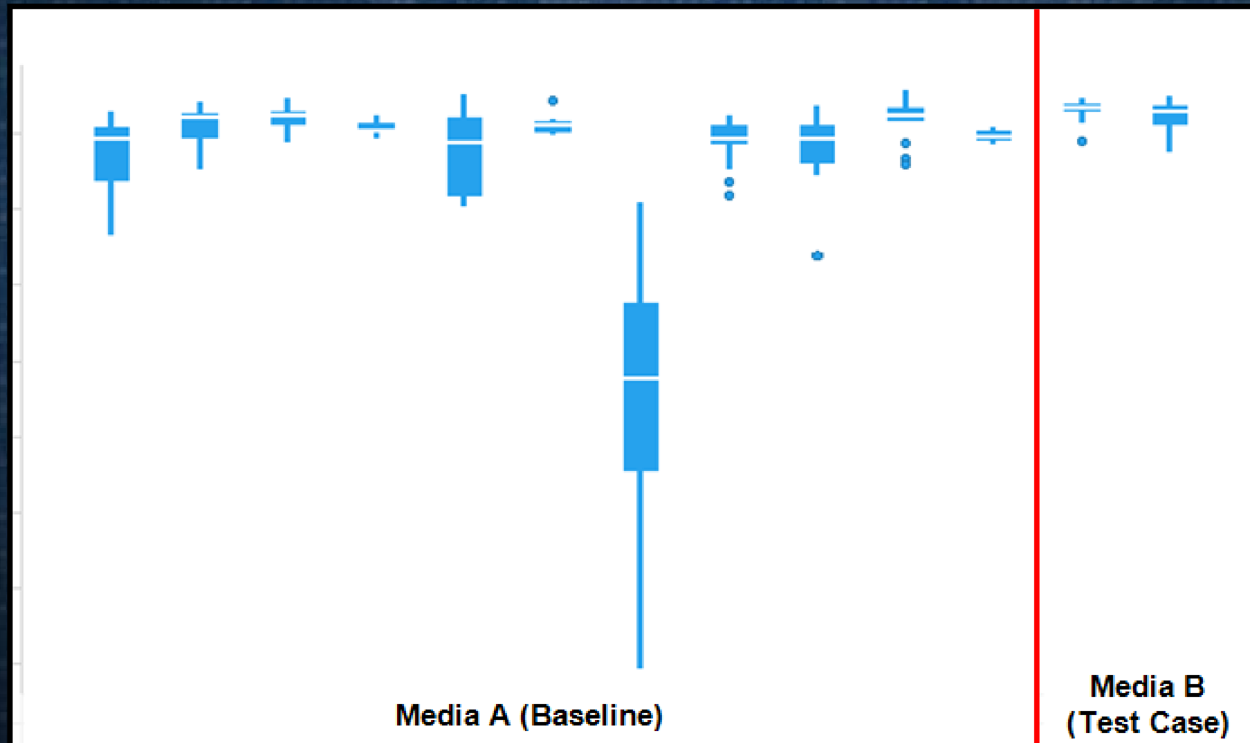




Probe tips show minimal wear post run

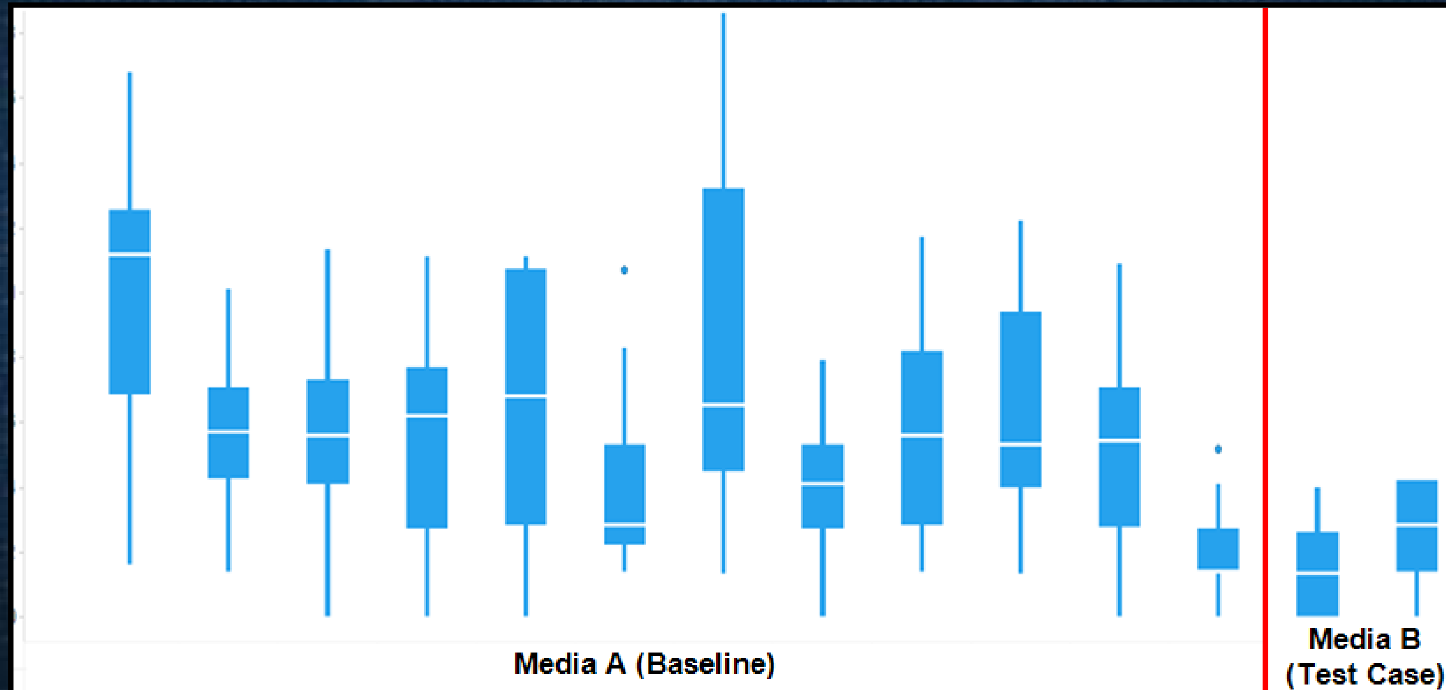
How does Device CRES Compare?

- Lapping Film (Test Case) CRES Improvement Validated via Good Die Tested



How does Device CRES Compare?

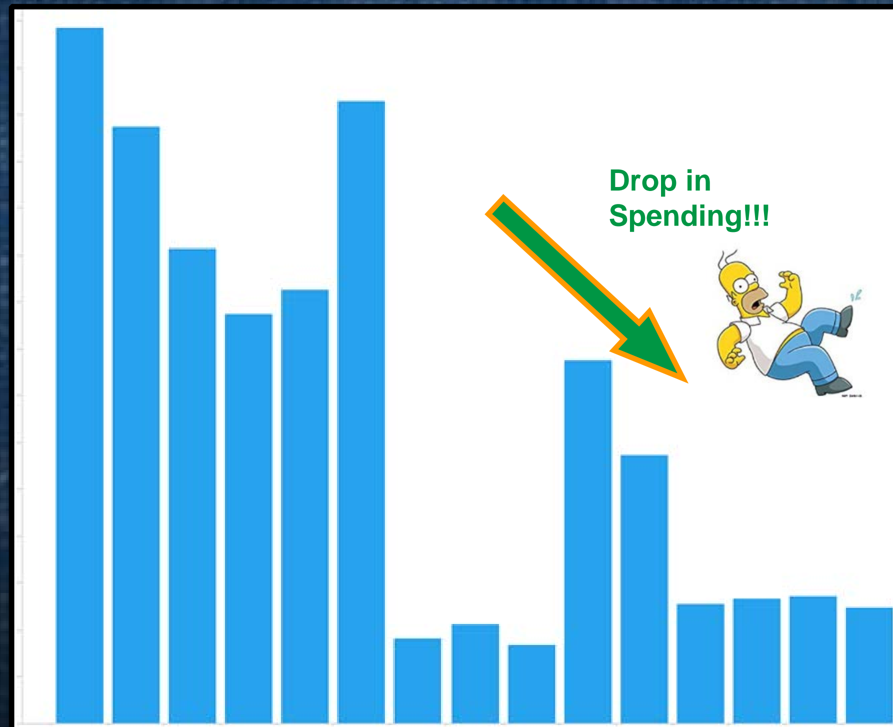
- Lapping Film (Test Case) CRES Improvement Validated via Contact Sensitive Bin %



Cost Benefit

- **Conversion from Polymer to Lapping Film has resulted in 77% Cost Reduction Month on Month**

Monthly Media Spend



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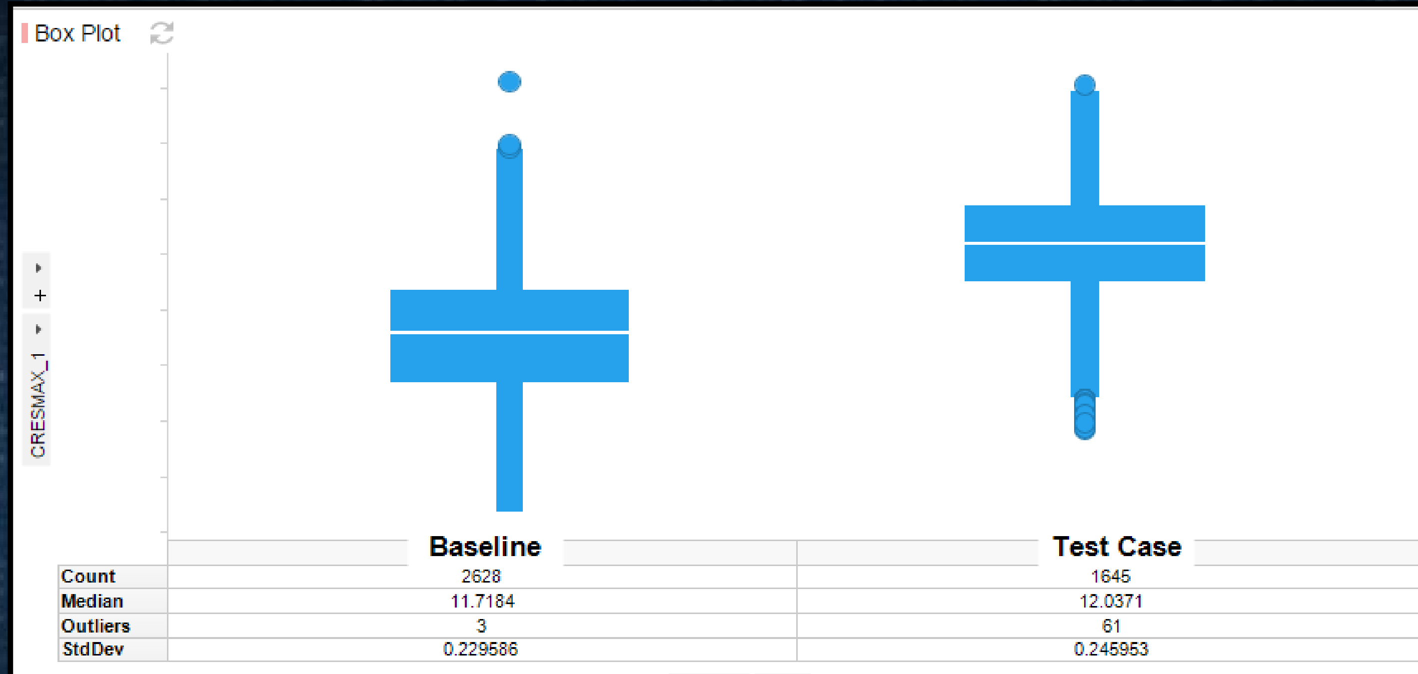
MEMS Vertical Spring Cleaning Optimization

- **MEMS Vertical Spring evaluated is FormFactor's Katana Probe on Al pad for wire bond applications**
  - Qualification presented at SWTW (S08_04_Stillman)
- **TI uses FormFactor's Standard Katana K2 Probe on Pad**
- **2 Part Evaluation of Recipe Change for Sameness**
  - Cleaning Overdrive Reduced
  - Probing Touchdowns vs Cleaning Touchdowns

CRES Result from Cleaning Recipe Change



	Baseline	Test Case
Count	2628	1645
Median	11.7184	12.0371
Outliers	3	61
StdDev	0.229586	0.245953

- Reduced Cleaning Overdrive 37%
- Increased number of probing touchdowns between cleans 36%
- Test Case still statistically in control
- 75% increase in Card Lifetime!!!

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Summary of Findings

- **Cleaning Material Evaluation on MEMS Cantilever Spring**
  - Lapping film shows improvement in CRES over Polymer
  - Lapping film does not significantly reduce probe card life (~5%)
  - TI is seeing a 77% media spend reduction by converting to Lapping film
- **Reduction in Online Cleaning Extending Probe Card Life on MEMS Vertical Spring**
  - 37% reduction in cleaning overdrive
  - 36% increase of probing touchdowns between cleans
  - CRES Statistically in Control
  - Increased card life by 75%

Acknowledgement

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Questions