Probe Card Stability during High Temperature Testing

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Overview

• Overview of Nidec SV TCL
• Introduction on High Temp Probing Challenges
• Motivation
• Approaches for Experiment & Simulation
• Experimental & Simulation Results
• Conclusions
• Future Work
Overview of Nidec SV TCL

- Established in 1994 as a US-based probe card supplier offering cantilever product.
- Acquired by Nidec-Read Corp. October 31, 2017
- Products to enable technology roadmaps in the high growth Mobile, Networking/Data, Automotive & Internet of Things “IoT” markets
- Strength through diverse product portfolio, turnkey solutions, global presence with manufacturing, sales & service centers worldwide
Introduction

• High temperature probing introduces extra failure modes that are not present at room temperature.
• Probe card stability at high temperature is a major issue & causes various failures.
Motivation

• Establish high temperature stability evaluation method.
• Develop FEA models to capture high temperature behavior.
• Counter measures to minimize stability issues.

What does probe card stability at high temperature entail?

- Initial stability (less critical, because it is compensated during testing).
- Stability during probing (very critical, because it is not compensated).

Soak Recipe (at use)
Card Material (at design)
Card Geometry (at design)
Probing Optimization (at use)
Approaches – Experiment

• **Setup**
  – J750 Platform Sample Card
  – Test Floor Operations
  – Simultaneous Deflection Measurement & Temperature Mapping

• **Experiments**
  – Soak Study
  – Component Level Study
  – Improvement Concept Study
Approaches – Simulation

• Setup
  – Thermal Simulation Module
  – Input Thermal Results to Structural Module
  – Predict Deflection from Structural Module
Results – Soak Study

• Every probe card has one unique stability state.
• There are different paths to reach the stability state & some take less time.
Results – Component Level Study

- PCB is the most unstable component in the probe card assembly, making up for 80% to 90% of total deflection.
- Improvement concepts should focus on isolating PCB from the assembly.
Results – Improvement Concept Study

- Material Change
- Design Change to Isolate PCB
- Soak Recipe Optimization

<table>
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<th>#</th>
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<th>Concept</th>
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<tbody>
<tr>
<td>1</td>
<td>1.1a</td>
<td>Change component material</td>
</tr>
<tr>
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<td>2.1a</td>
<td>Add thermal control component design 1</td>
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<tr>
<td>3</td>
<td>2.1b</td>
<td>Add thermal control component design 2</td>
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<td>4</td>
<td>2.1c</td>
<td>Add thermal control component design 3</td>
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<td>Isolate PCB from system design 2</td>
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<td>2.3a</td>
<td>Modify stiffener design 1</td>
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<td>8</td>
<td>2.3b</td>
<td>Change mounting mechanism within components</td>
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</tbody>
</table>

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## Results – Improvements Combination

### High Pin & High Temperature Solution
- 20% initial stability improvement.
- 81% stability during probing improvement.
- Stable within Stage I soak, approximately 30 minutes.

### Low Pin & High Temperature Solution
- 42% initial stability improvement.
- 84% stability during probing improvement.
- Stable within Stage I soak, approximately 30 minutes.

### Improvement Concept Combination DOE

<table>
<thead>
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<th>2.3b</th>
<th>1.1a</th>
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<th>Initial stability</th>
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</table>

- High Pin & High Temperature Solution
- Low Pin & High Temperature Solution
1. Typical soak recipes assume equal operation time & recovery time, but on the sample card, it is found that short operations take a long time to recover.

2. Recovery vs. operation time is very likely platform dependent.

![Recovery Time vs. Operation Time](image-url)
Simulation – Correlation to Experimental Data

* FEA model showed good temperature & deflection correlation to experimental data.
Simulation – Boundary & Contact Effects

• High temperature simulations are much more sensitive to boundary & contact conditions than room temperature setups.
• Great care must be taken in modeling & results interpretation.

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Simulation – Capabilities & Limitations

• Although capable of predicting general probe card high temperature behavior, the demonstrated model also has limitations in capturing subtle contact changes in real life cases.

• This type of model requires large amount of calibration data from experiment.
Conclusions – In General

• Probe card high temperature stability includes initial stability & stability during probing.
• Every probe card has one unique stability state, as a function of card construction & material composition.
• By adjusting soak procedures, the path to reach stability state can change & certain paths require shorter time.
• Improvements made to change card construction or material composition may interact & their application needs to be determined case by case.
• Every card has as its own recovery time vs. operation time characteristics, likely dependent of platform.
• High temperature simulation models are highly sensitive to BC & contact setups.
Conclusions – J750 Type Specific

• The PCB is the most unstable component in the probe card assembly.
• Short operations such as cleaning and wafer change take a long time to recover.
• Our high temperature solutions are applicable to other platforms similar to J750 with stiffeners only in contact with PCB.

<table>
<thead>
<tr>
<th>High Temperature Solutions for J750 &amp; Similar Platforms</th>
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<tr>
<td>Time to Initial Stability</td>
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<td>&lt; 30 minutes</td>
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Future Work

• Platform variation study
• Low temperature study, which is suspected to be a close reverse of high temperature, but not exact.
Acknowledgements

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Questions?