Challenges of Trench Probing

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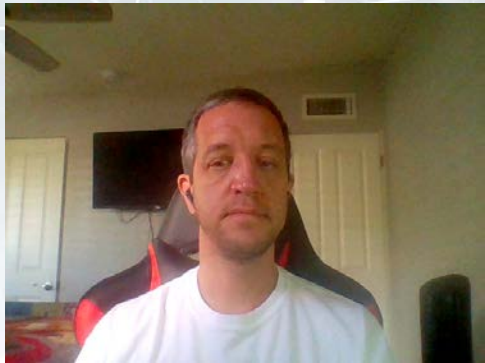
PROBE TODAY, FOR TOMORROW

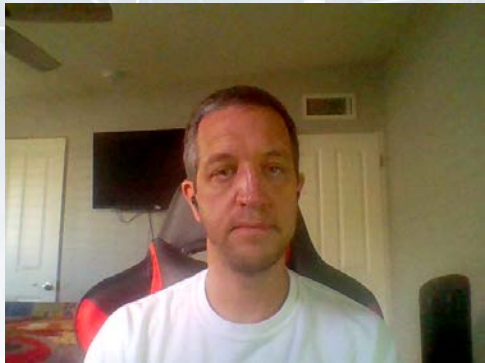
Introduction of Application

- **Where do you turn when the application typically used is cantilever but now a more modern solution is needed?**
  - Turn to a vertical solution, right?
- **Where do you turn when the application does not function correctly with a vertical solution?**
  - Back to cantilever?
  - Request custom solution?
  - Will a spring pin work for a standard aluminum pad?
    - What about Contact-related issues?



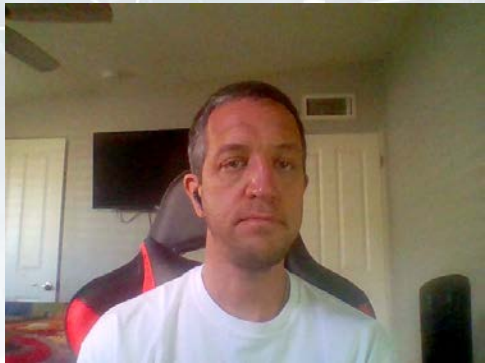
Background & Overview

- **Internal NXP customer had the following requirements:**
  - Probes needed to have zero float to PCB
  - Ability to probe standard bond pads & bond pads in a trench
  - Trace length and width matching within sites to control impedance
  - Tip extension below the PCB needs to be the same for standard bond pads & bond pads in trench for ease of setup.
  - Field Repairability
  - Vendor support at factory sites in Asia



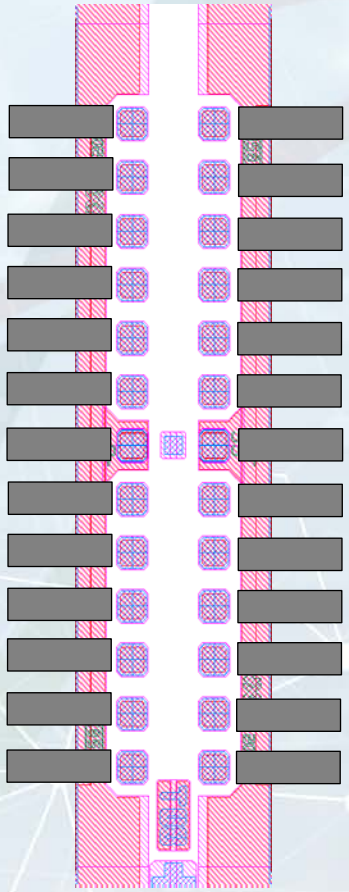
Challenges Encountered

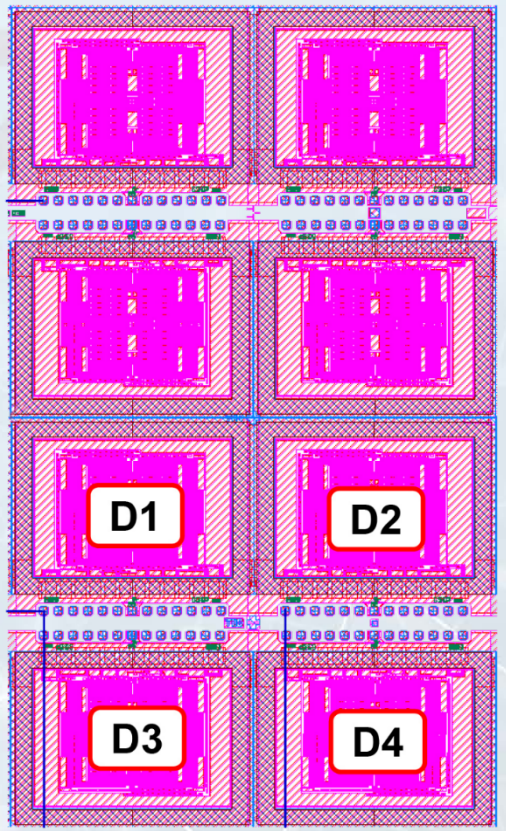
- **The main challenge with this device was probing the trench on the wafer; these challenges were as follows:**
  - Depth of Trench
  - Product Electrical Requirements
  - Restriction on total height from top of PCB to end of tip
  - Constant Electrical Contact – Due to this requirement the usage of traditional vertical technology was not an option. Cantilever was also not suitable due to crosstalk.
- **Utilizing Nidec/SV MEMS technology, we were able to design a probe head with a straight probe & longer tips allowing the probes to be in constant contact with the space transformer while at the same time probing inside the trench.**



Device Specifications

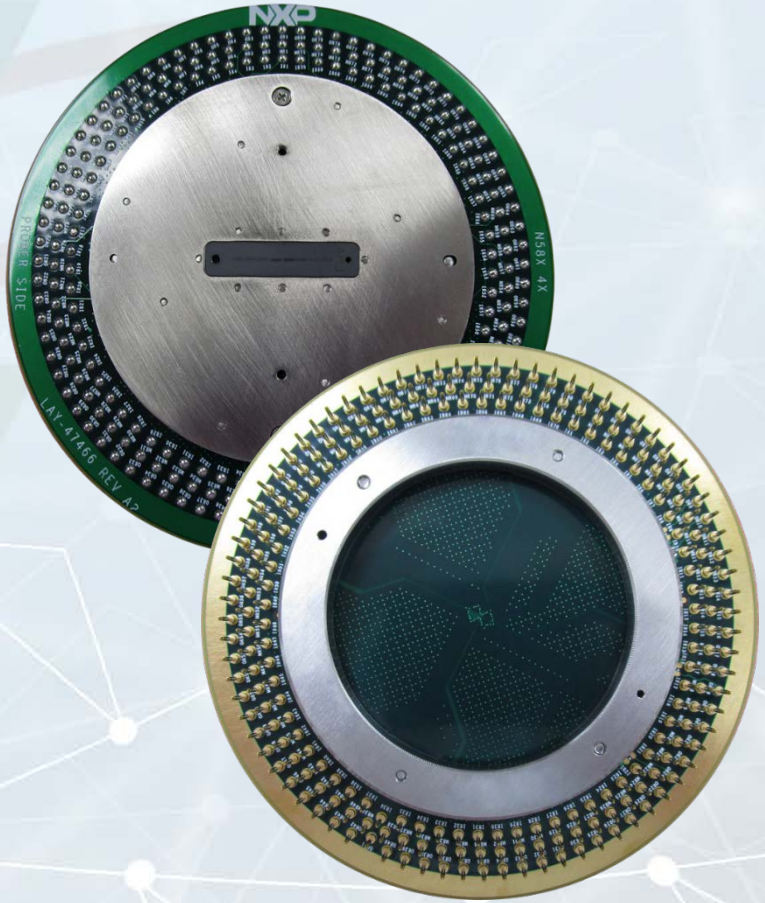
- **Device specifications:**
  - Pad size 77µm x 77µm
  - Pad spacing is 140µm
  - Trench
- **Probe Type:** MEMS – P80
- **Customizable Probe force per probe at Working OD:**
  - **At working OD:** 1.8 grams
  - **General:** 15.2 gf/mm
- **Space Transformer Attach Method:** Direct Attach
  - Other ST Options, Wired, MLO, MLC & Modular
- **Tip Shape:** Radius, Non-Rotate
  - Additional Tip Shape Options – Flat, Crown
- **Tip Diameter:** Radius (10 +/- 3µm)
- **Tip Depth:** 2.34mm +/-0.25mm, from Wafer Side of PCB

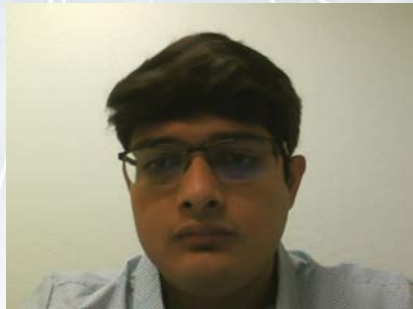




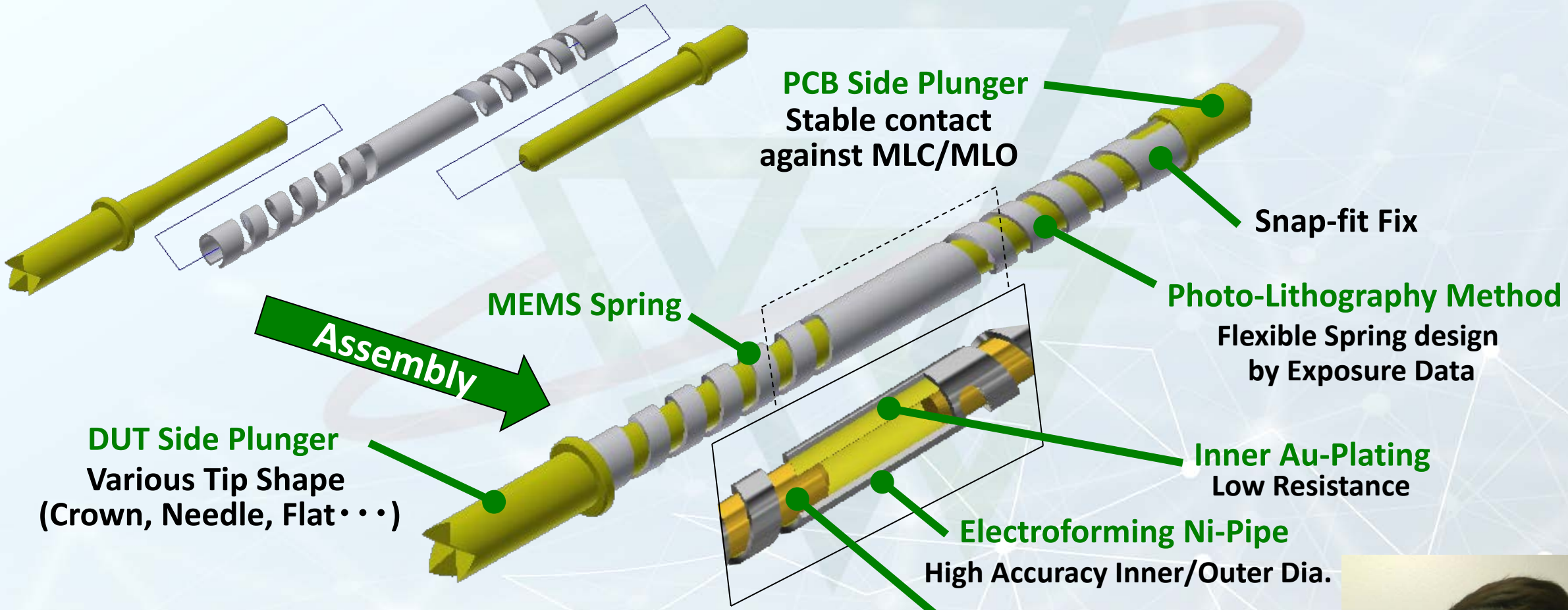
MEMS Probe Card – Keepout Requirements

- By maximizing the Keepout for the PCB we were able to maximize the pin count; in addition, by retaining the same KO, the Probe Head (PH) can be utilized for future devices using a similar PCB.
- PCB had just a 50mm diameter space for the PH so we customized our MEMS technology to meet this requirement.
- We managed the mechanicals on our Keepout so that the card achieve impedance match & equal trace widths across all the dies.
- We relocated the probe head attach screws to help achieve the PCB design requirements & reduced the pad size to allow enough room to match the trace widths.



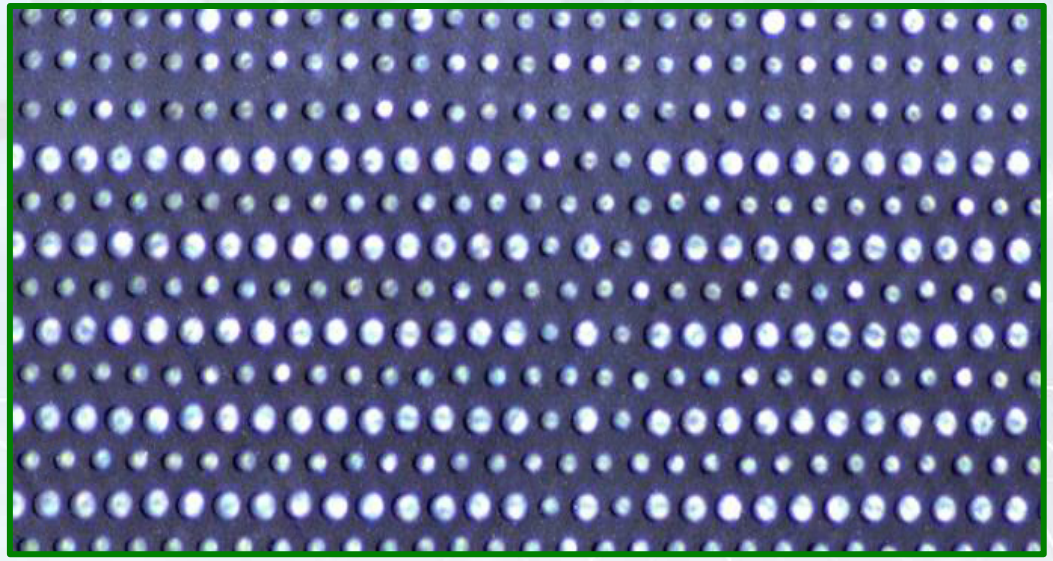


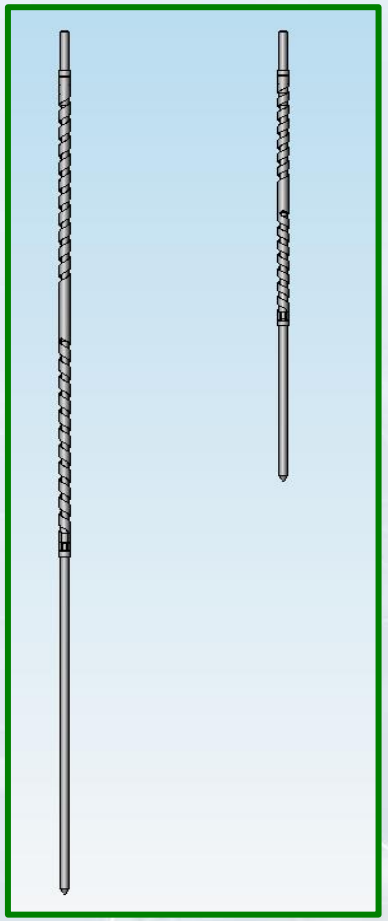
MEMS Probe – Assembly Example



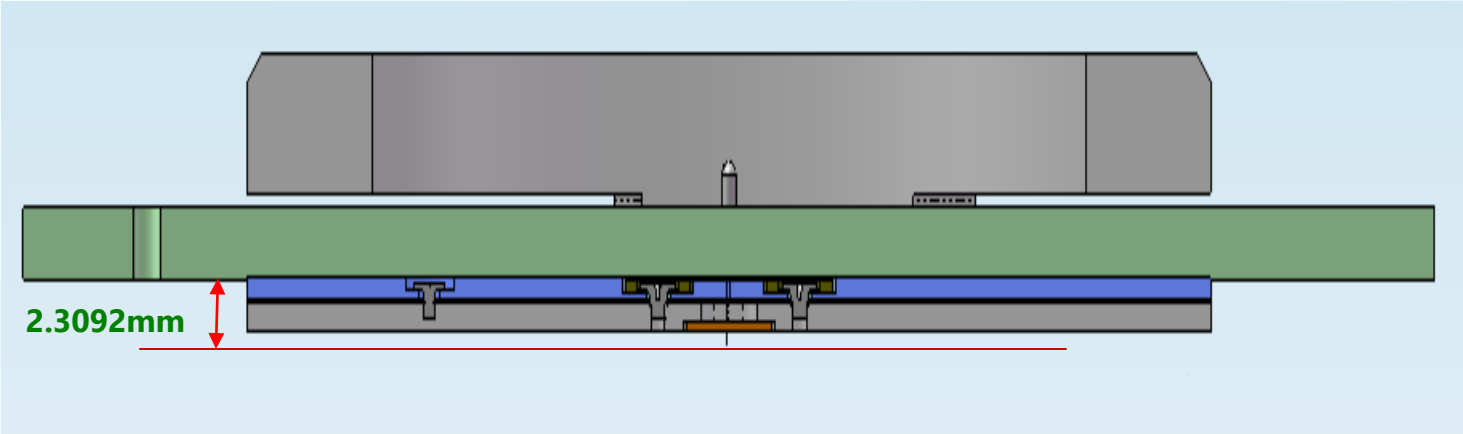
MEMS Probe Flexibility

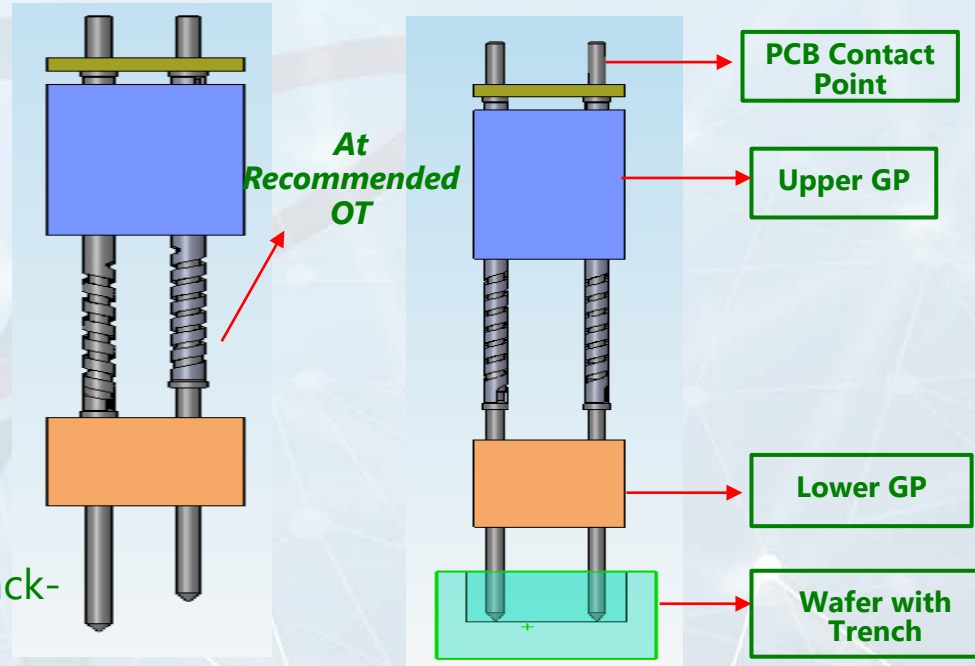
- Due the tip depth requirement we had to use a custom short probe which was possible due to the unique & flexible design of MEMS probes.
- These MEMS Probes can be customized for Force, Stroke, Overdrive & Tip Style giving us the capability to achieve the electrical & mechanical requirements.
- Along with optional torque rotation, the flexibility of this MEMS Probe also gives us the capability to create Hybrid Pin layouts for higher CCC.





MEMS Probe Card – Custom P80 MEMS Probe

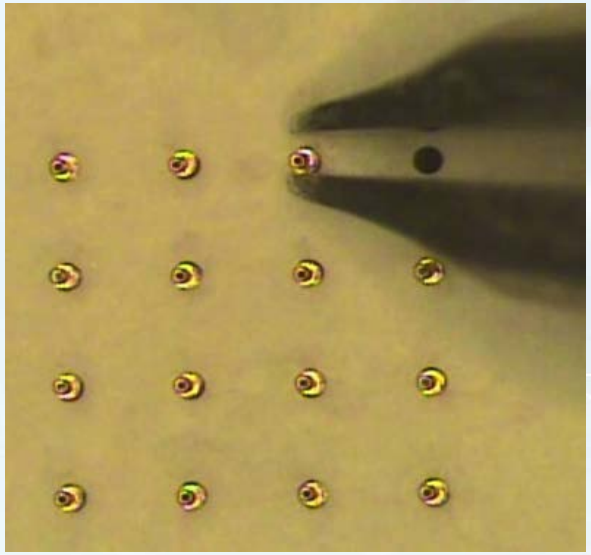


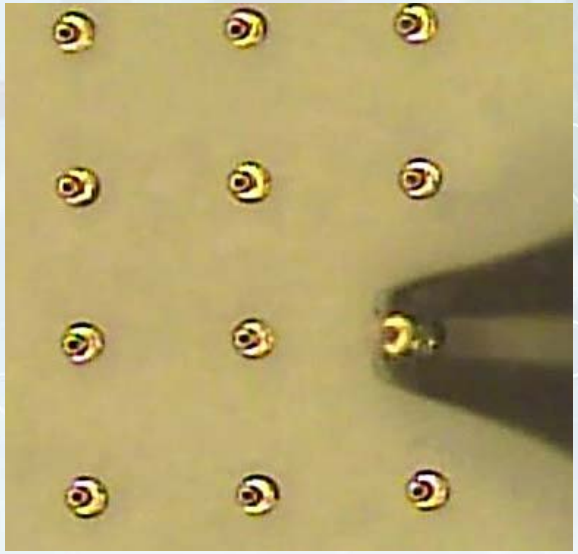


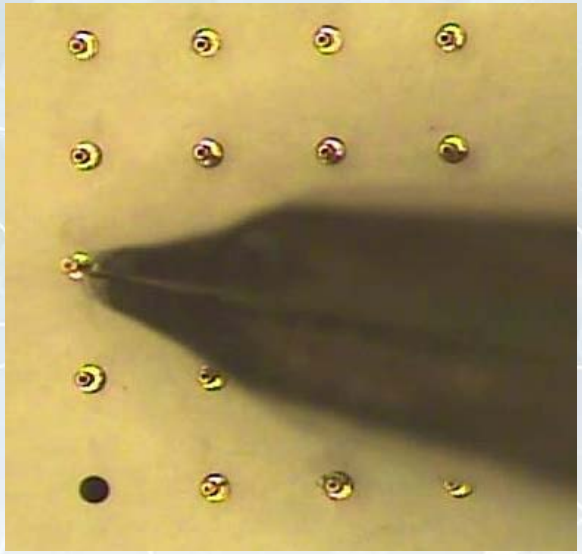
- 2.3mm of tip depth requirement resulted in the redesign of the mechanical stack-up to guarantee enough support to the probe in addition to achieving higher tip extension.
- FEA simulation & deflection results helped us in designing a stack up using thinner guide plates.
- Thinner Guide Plates (GP) with vertical compression gives us the capability to go inside the trench & probe the device underneath the trench.
- Our PH was built so that the wafers can be switched to aluminum or trench probing without any further prober setting adjustments.

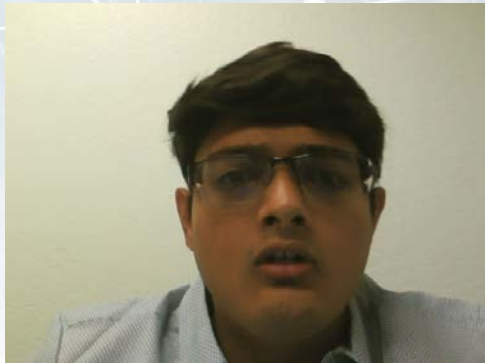
MEMS Probe Repair & Replacement

- Our MEMS cards can also be easily repaired in-house after minimal training.
- Probes can then be removed & replaced with ease onsite or at one of our worldwide facilities.
- Our MEMS Probes are easily field replaceable which can save valuable time in production.

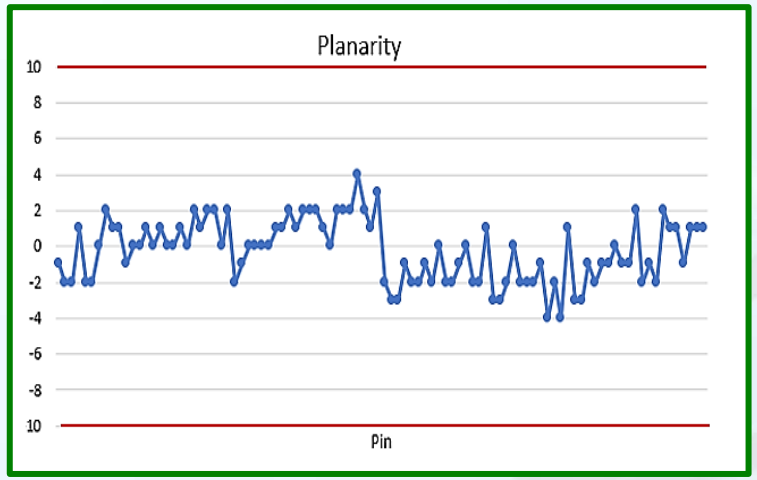




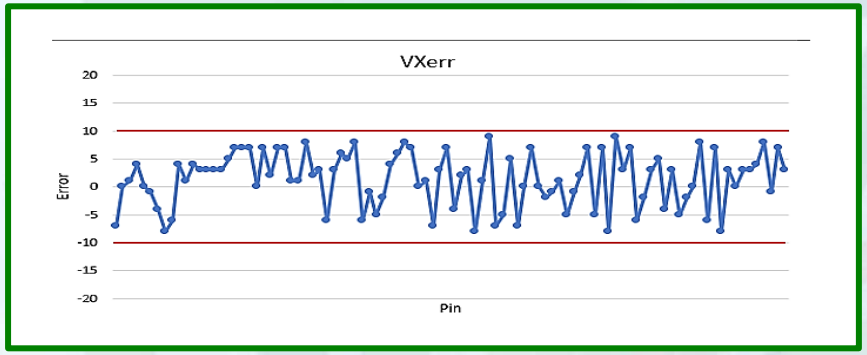


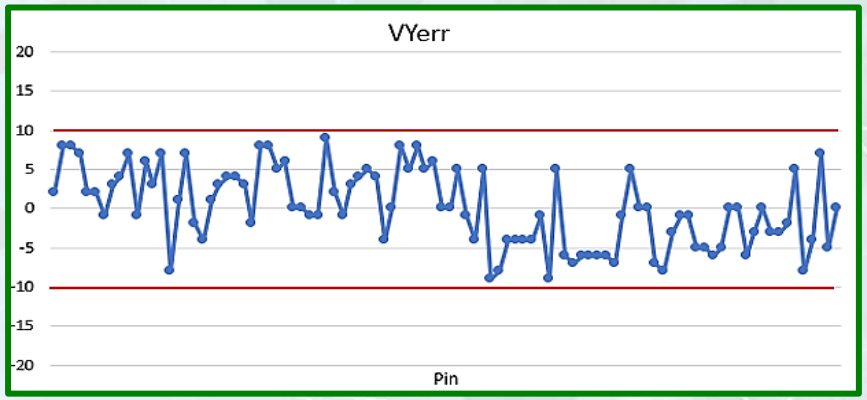


PCA Test Results

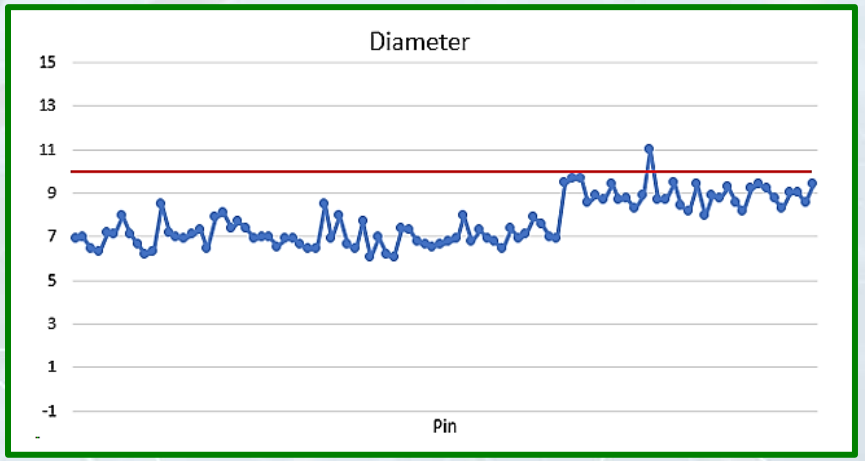


Planarity

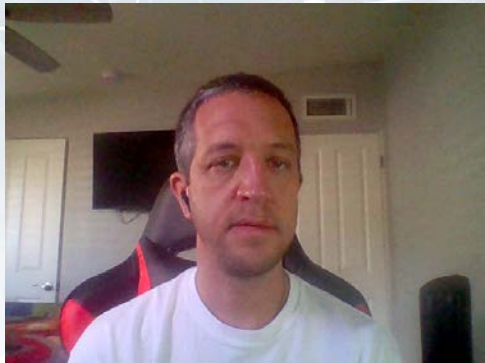




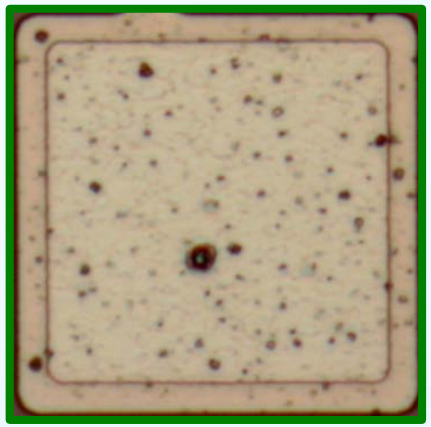
Alignment



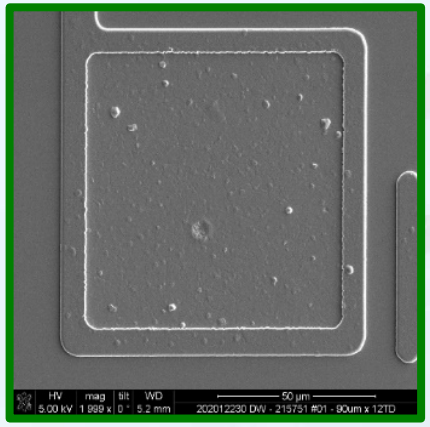
Tip Diameter



Probe Mark

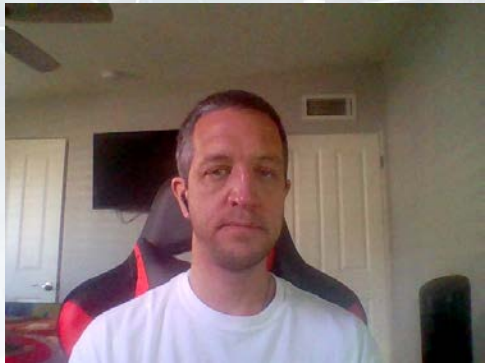


Probe Mark after 12 TD's



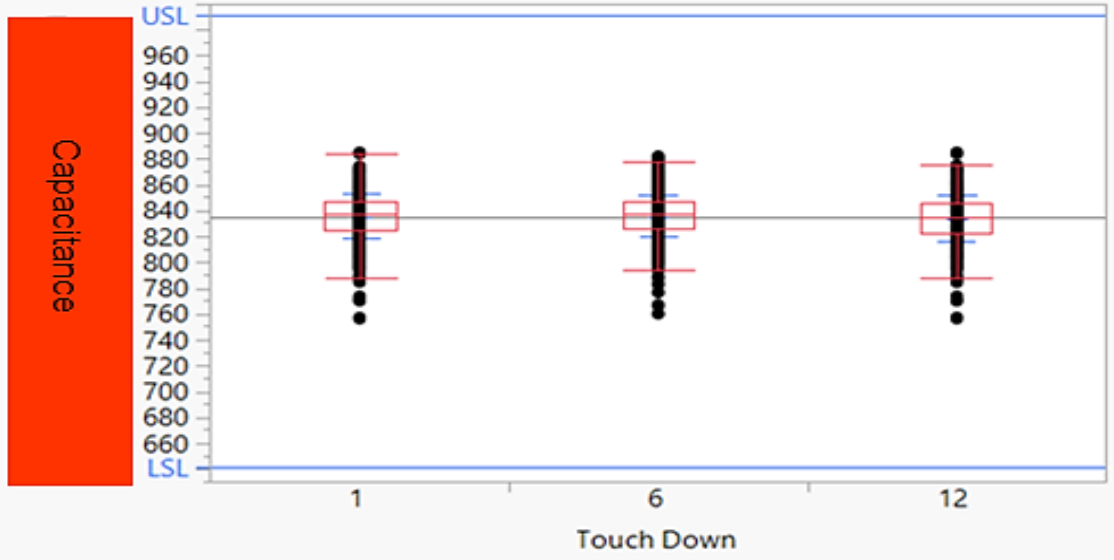
Probe Mark after 12 TD's, after Aluminum Removal

- 12TD's on the bond pad left 25% of aluminum remaining under the probe mark. No cracking observed.



Contact Results

Oneway Analysis of 5400:D_CH0_CAP00_LH00_SN_0p0 of DOE1 By Touch Down



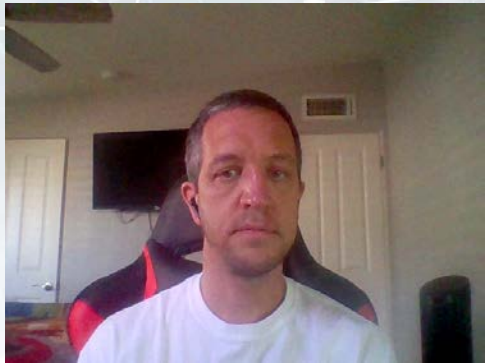
Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
1	755.5216	813.2699	823.8455	835.9878	848.0594	857.2206	885.5087
6	759.4015	814.0464	825.4687	837.3255	846.6937	856.1139	882.5383
12	755.5862	811.5236	822.1782	834.7388	846.0535	855.554	885.5162

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
1	1482	835.53337	17.829678	0.4631476	834.62487	836.44186
6	1482	835.86409	16.599687	0.4311971	835.01826	836.70991
12	1482	833.93003	17.451215	0.4533166	833.04082	834.81924

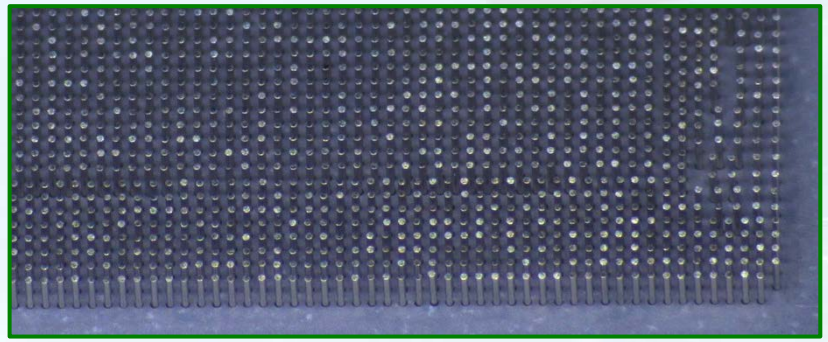
**Contact resistance not possible for this product. Contact sensitive capacitance test was used as replacement to measure results.

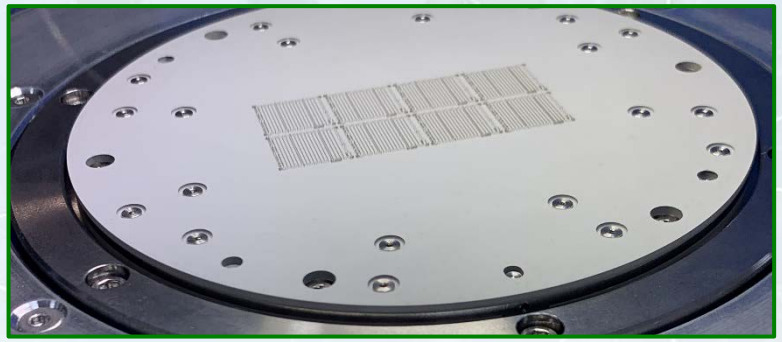


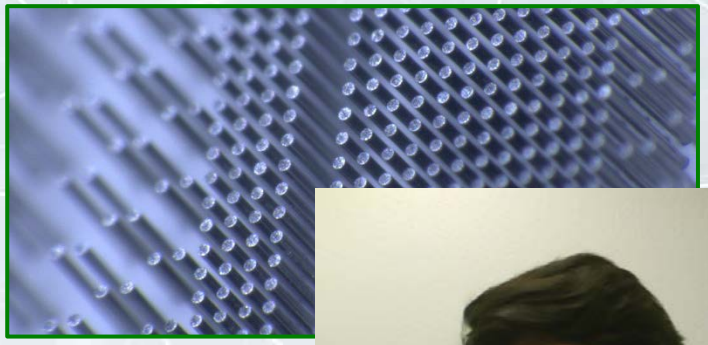
Twitchell/Maniar

Next Steps

- Monitor the current solution's test results over the product lifetime.
- Nidec SV TCL team is now working on a direct attach solution for fine pitch with the trench on the wafer.
  - Current solution is using a P80 MEMS probe for smaller pitch.
  - Next solution will need to achieve a similar performance with a tighter pitch.
- Future plan is to develop a solution with our MEMS technology for a wafer with a deeper trench.

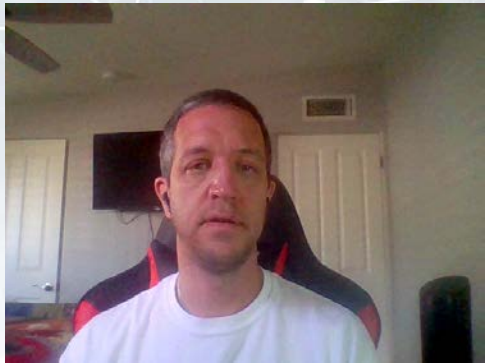






Summary

- Nidec/SV MEMS probe design allowed NXP to meet the setup requirements from internal customer
- Probe card stability was proven over multiple touchdowns and overdrive variations
- Probes are field replaceable allowing production to reduce inventory of probe cards as compared to cantilever probe cards required
- Design of probe card allows internal customer to quickly adapt for future products shortening the NPI life cycle



Thank You

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