How to Reach more than 1 Million Touchdowns per Probe Head when Testing High Current / High Pin Count Microprocessors ???

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AGENDA

- Probe Card - Requirements
- Probe Card - Issues Testing on Bumps
- Test Program – Protecting the Probe Card
- Probe Card Maintenance - Cleaning Methods
- Probe Card Tracking System
- Summary
Probe Card - Requirements

• Trends
  – Increasing number of I/O pins
  – Increasing number of power and ground pins
  – Smaller pad pitches
  – Smaller probe diameter
  – Voltages decreasing
  – Current increasing
  – Power is exponentially increasing

• Challenge
  – Keep the total cost of ownership for the probe hardware down and guarantee a high probe card performance all the time!!!
Probe Card – Issues Testing on Bumps

- Probe Needle – Schematic (not to scale)

MLC – Gold pad  \[ \{ \text{MLC- } C_{\text{res}} \]  

Probe – Needle

Bump  \[ \{ C_{\text{res}} \]
Probe Card – Issues Testing on Bumps

• **Burning Probes**
  
  – Can be caused by bump material between needles \(\Rightarrow\) shorts between adjacent probes

  ![Image of probes]

  – \(C_{\text{res}}\) increases due to sticky bump material on the needle tip
    \(\Rightarrow\) more current goes through other clean probes with low \(C_{\text{res}}\)

  – MLC-\(C_{\text{res}}\) increases due to pad wear out \(\Rightarrow\) more current goes through other clean probes with low \(C_{\text{res}}\)
• Burning Probes (continued)
  – Asymmetrical power distribution in the power and ground grid due to wafer manufacturing process issues

All this can cause burned probes
How to Determine that there are Burned Probes ???

- Burned probes change their mechanical shape over time due to the applied mechanical force from the prober-chuck when getting in touch with the wafer – high current heats up the probe and the applied contact force can deform the needle.
Probe Card – Issues Testing on Bumps

• How to Determine that there are Burned Probes ??? (contd.)
  – Probe head planarity is a very good indicator ⇒ mechanical and electrical performance of the probes is proportional to the overall probe head planarity
  – Measure the planarity for all signal, power and ground needles off-line at the probe card check station
  – Measure the planarity for all signal pins at every lot start at the prober-tester system ⇒ probe card on-line process control

  Do replace probes in the probe head if they are out of the planarity spec-window !!!

PREVENTIVE PROBE CARD MAINTENANCE
Probe Card – Preventive Maintenance

• Probe Card Maintenance - Plating
  – Mechanical wear-out problem over time
  – Re-plating MLC Gold contacts $\Rightarrow$ reduces MLC-$C_{res}$

MLC-Gold pad - mechanical wear-out
Probe Card – Preventive Maintenance

• Probe Card Maintenance – Lapping Backside
  – Probe backside lapping ⇒ increases contact area ⇒ reduces MLC-$C_{\text{res}}$

Before-Lapping

After-Lapping
Probe Card – Preventive Maintenance

- **Probe Card Maintenance – Cleaning Probes**
  - Probe tip cleaning / lapping $\Rightarrow$ reduces $C_{res}$
  - Probe tip cleaning on-line at the prober and off-line

![Before-Cleaning](image1.png) ![After-Cleaning](image2.png)
• **Probe Card**
  – Preventive probe card maintenance improves the performance and life of the probe hardware

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**Impact Maintenance Methods**

- **Start Preventive Maintenance –** Plating, Planarity-Spec
- **Probe Backside Lapping**

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*Southwest Test Workshop 2002*
Test Program - Protecting the Probe Card

- **Test Program - Probe Card Protection Tests**
  - Signal Pin Continuity Tests - OPENS / SHORTS
    - Abort testing when fail
  - Power-Ground Continuity Test
    - Abort testing when fail
  - Power-Supply Shorts Test – current monitoring
    - Abort testing when fail
  - Device - Power-Up-Static Test – power up the part at a low voltage, run a pattern and stop ➞ measure static current
    - Abort testing when fail
  - Current Clamp Alarms – monitor the power supply current while testing the part for each test executed
    - Abort testing when fail – exceeding a defined current limit
Probe Card Tracking System

• Probe Card Tracking - Purpose
  – Efficient system to keep track of all relevant probe card parameters and maintenance events
    • touchdown count
    • maintenance events - MLC re-plating, replacing probes
    • X-Y alignment parameters
    • overall planarity
    • Probe card relevant operation parameters

Tag attached to probe card
RF-Micro-Tag with mounting kit
Probe Card Tracking System

- Probe Card Tracking (continued)
  - Defined limits for all probe card parameters for each probe card type
  - Tracking of maintenance events
Probe Card Tracking System

- Probe Card Tracking (continued)
  - Probe card real time status information available
  - All data will get loaded into a database ⇒ trends and charts can be used to monitor probe card performance ⇒ Statistical Probe Card Process Control possible !!!
Conclusions

• Need to understand the possible root cause of probe burning
• Use the planarity of the probes as a parameter to qualify the probe card quality on the test floor on the test system
• Preventive Maintenance guarantees high quality of the probe card for the entire life in the field
• Probe card protection tests implemented in the test program help to reduce the risk of damaging the probe card while testing
• Probe Card tracking system can be used for statistical process control and monitoring the quality of the probe card
Conclusions

• With the methods and tools in place more than 1.5 million touchdowns per Probe Head and more than 2 million touchdowns per Space Transformer using the same MLC could be achieved – still in use ⇒ numbers will increase even more

TOTAL COST OF OWNERSHIP REDUCED !!!
PERFORMANCE OF THE PROBE CARDS STAY AT A HIGH LEVEL FOR THE ENTIRE LIFE OF THE PROBE HARDWARE !!!