Application of Contact Resistance in Parametric Testing

Intelligence Accelerated™

Iwan Putra Kurniawan
Micron Semiconductor Asia, Singapore

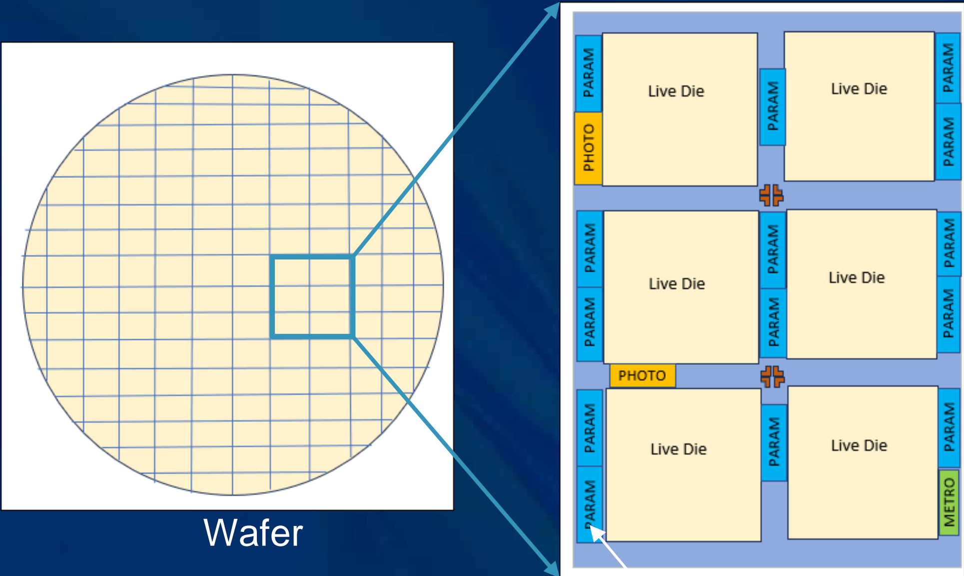
4th Annual SWTest Asia | Hsinchu, Taiwan, November 2-3, 2023

Overview

- Parametric Testing in NAND
- 3D NAND Evolution
- Testing 3D NAND Parametric with Multiplexer Module
- Challenges in Troubleshooting MUX Test Fails
- Contact Resistance (CRES) Test as option
- Limitation of CRES and hardware diagnostic
- Summary

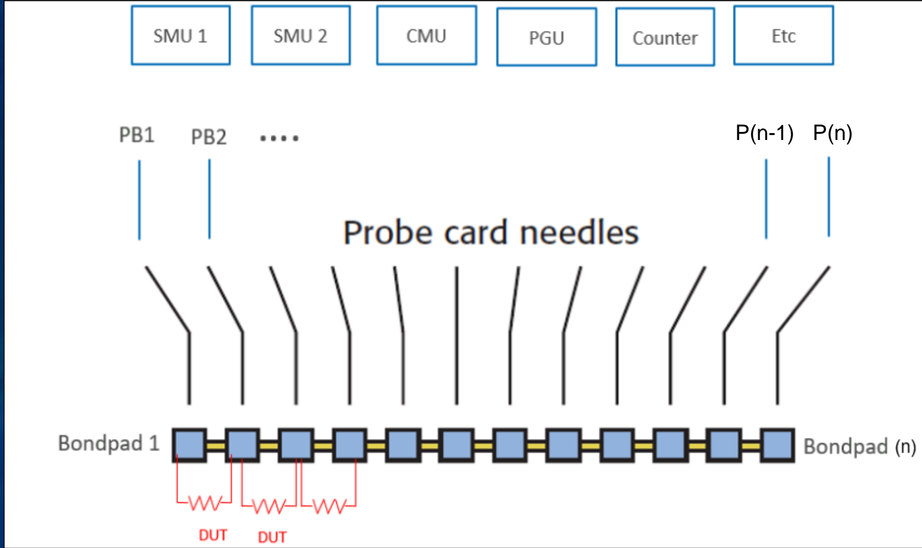
Parametric Testing in NAND

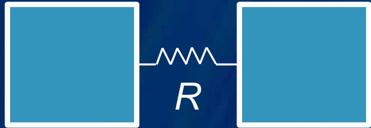
- Functional test is electrical test to check good or bad die.
- Parametric test is electrical test to check internal structures.



Wafer

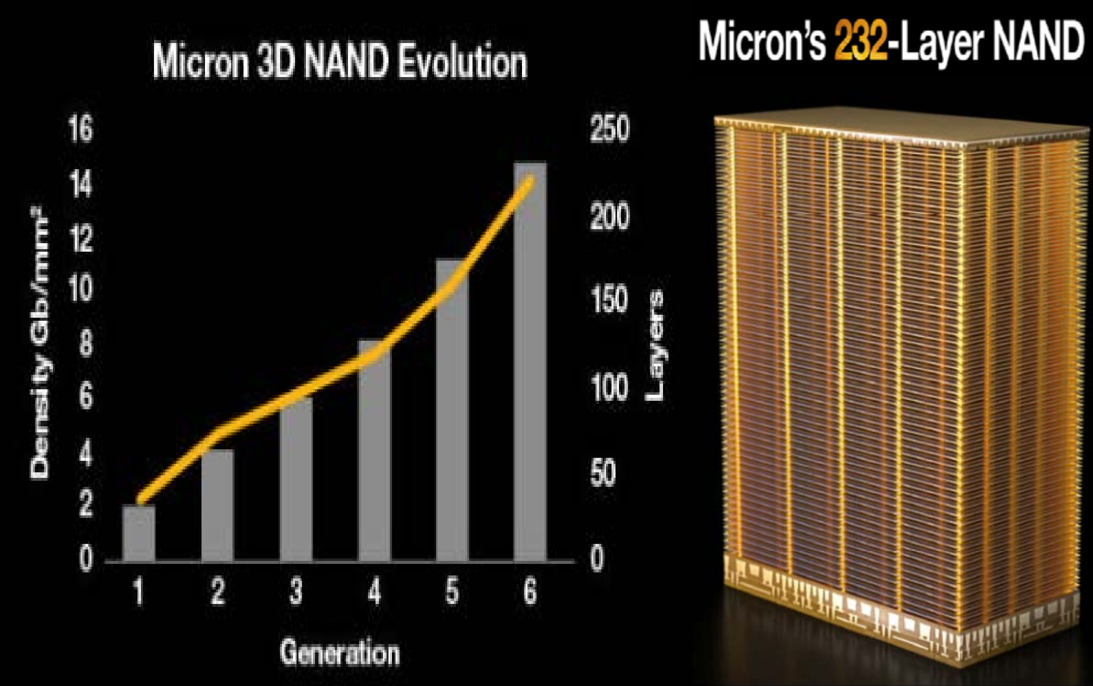
Param module



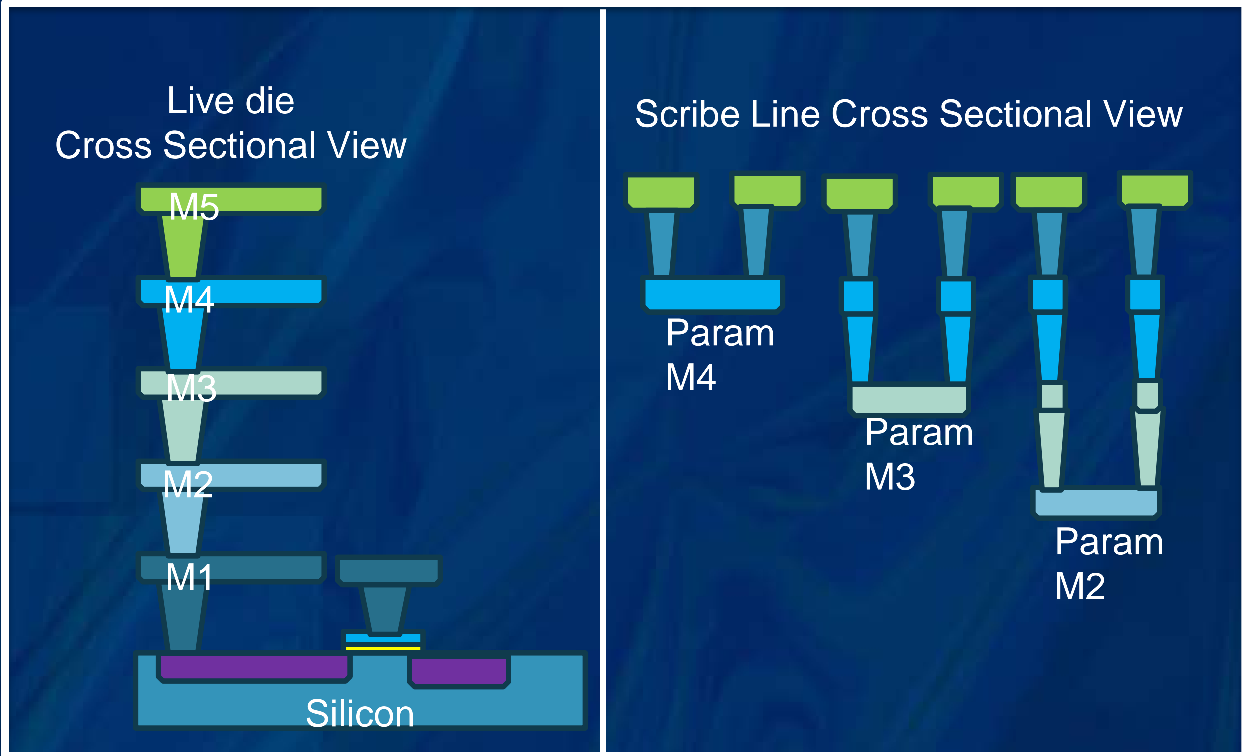


Parametric Test structure

3D NAND Evolution



Micron's 3D NAND Evolution: 232-Layer NAND



Hypothetical diagram, does not represent Micron design.

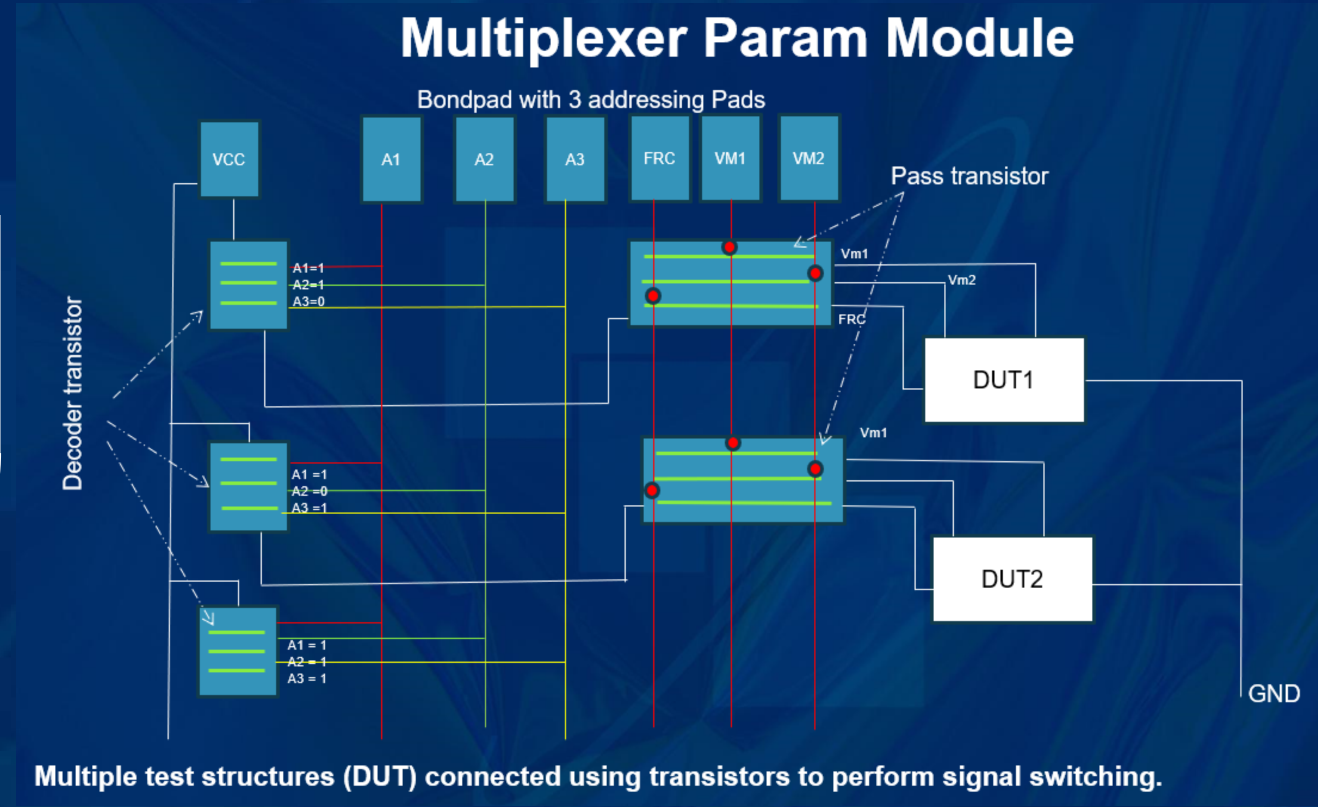
Testing 3D NAND Parametric with Multiplexer Module

- **Param Multiplexer (MUX) module could pack 10X~20X components vs standard module.**

Typical Param MUX Module Test Structure Connection Table

	Address	VM1	VM2	FRC	GND	VCC	Vbb/Vpp	Address High	Address Low
Test Structure 1	11110011	01	02	03	04	05	6&7	8&9&10&11	12 & .. (n-1)&(n)
Test Structure 2	01001001	01	02	03	04	05	6&7	11&13	8&9&10&..(n-1) & (n)
Test Structure 3	00010010	01	02	03	04	05	6&7	10&13 & ..(n-1) & (n)	7&8&9&11&12
Test Structure 4	10110011	01	02	03	04	05	6&7	9&10&12	8&11&13&..(n-1)&(n)
Test Structure 5	10010011	01	02	03	04	05	6&7	10&11&12	8&9&11&13&..(n-1)& (n)

Measurement pads (VM1, VM2, FRC) — MUX logic (VCC, Vbb/Vpp) — Addresses (Address High, Address Low)



Multiple test structures (DUT) connected using transistors to perform signal switching.

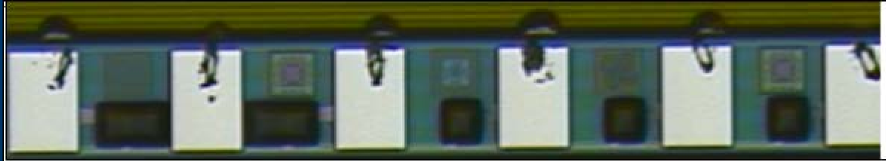
Problem Statement

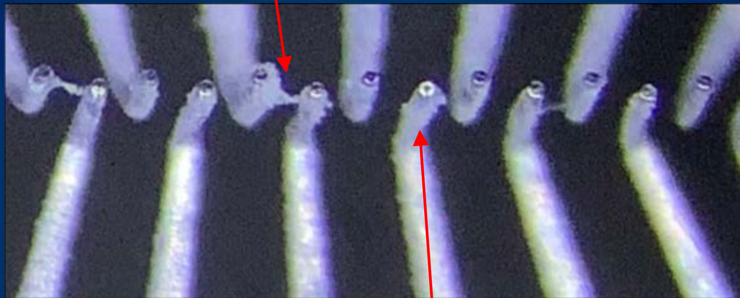
- **Param Multiplexer module poses challenge in diagnosing hardware issues.**
  - It is not straight forward to isolate faulty hardware.
  - Common issues are highlighted and a technique to isolate is illustrated in this presentation.

- **Why couldn’t the hardware self diagnose itself?**

Common Hardware Issues

Probe marks misaligned/ out of bond pads



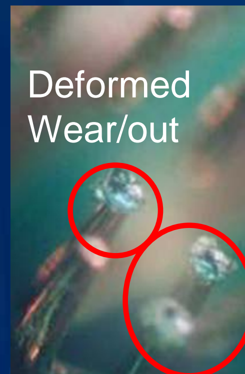


Dirty

Tip chip off

Loose connector

Bent tip



Deformed
Wear/out

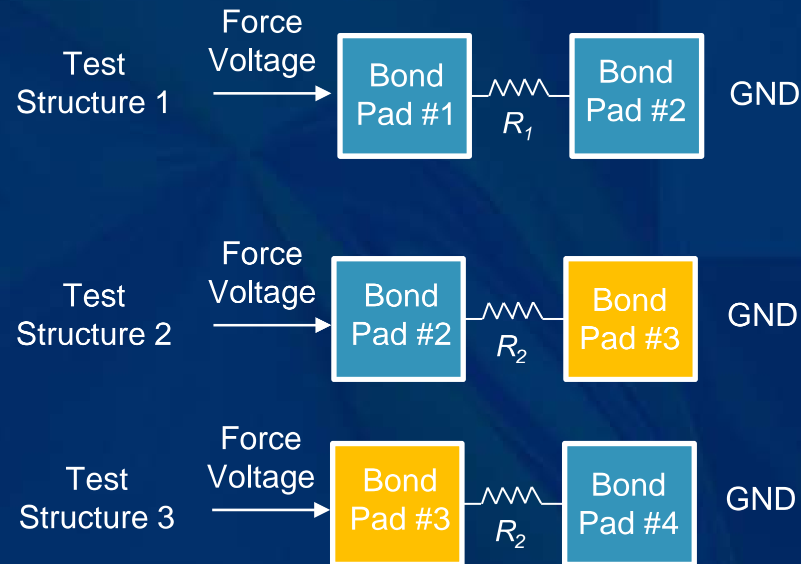
Faulty Equipment / Probecard

- **Mechanical Contact:**
  - Probe marks misalign/out of pad
  - Bent/burnt/deformed tips
- **Electrical Contact:**
  - Tester Board faulty
  - Loose / damaged connector

Pictures do not necessarily represent Micron's production condition

Challenges in Troubleshooting MUX Test Fails

Single Component Module



- **Commonality leads to Pin #3**

Multiplexer MUX Module

Typical Param MUX Test Structure Connection

	Address	VM1	VM2	FRC	GND	VCC	Vbb/Vpp	Address High	Address Low
Test Structure 1	11110011	01	02	03	04	05	6&7	8&9&10&11	12 & .. (n-1)&(n)
Test Structure 2	01001001	01	02	03	04	05	6&7	11&13	8&9&10&..(n-1) & (n)
Test Structure 3	00010010	01	02	03	04	05	6&7	10&13 & ..(n-1) & (n)	7&8&9&11&12

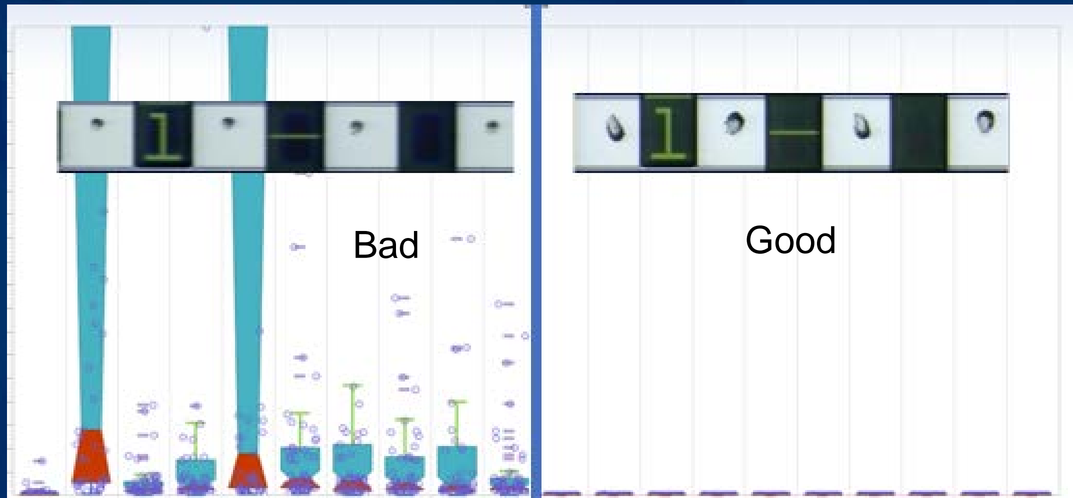
- **Unable to trace which Pin failing.**

Contact Resistance Test as option

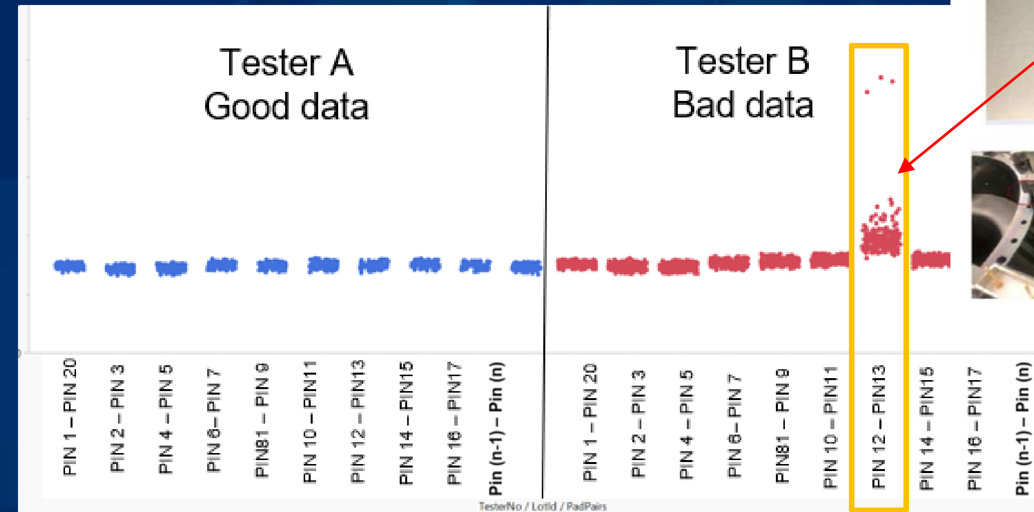
- **One way is to use Contact Resistance (CRES).**
- **What is CRES?**
  - Interface resistance between probecard lead tip and bondpad.
- **Why CRES?**
  - Most Issues are contact related.
  - Direct signal path measurement.
- **How can it help us?**

Example of CRES Application

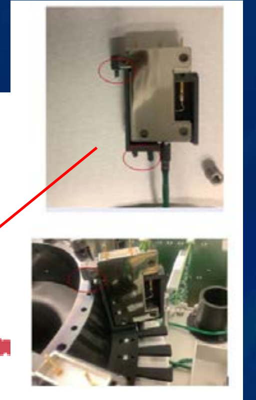
DETECTION



ISOLATION

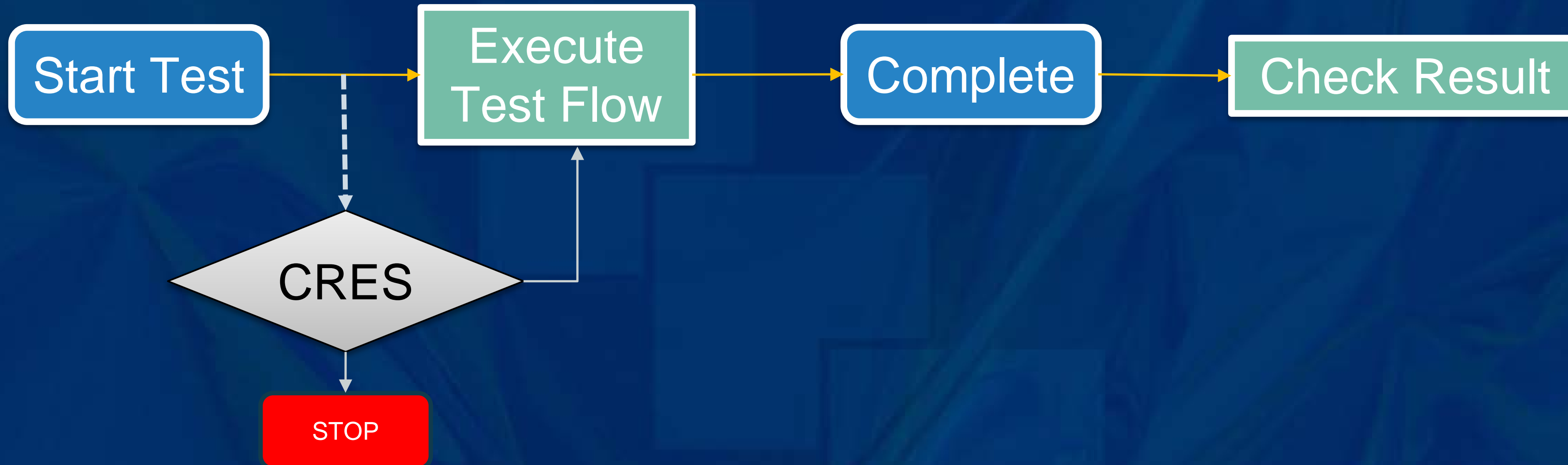


Pin Board
guide pin bent



- **Examples of Hardware Failure with CRES**

Shift Left CRES



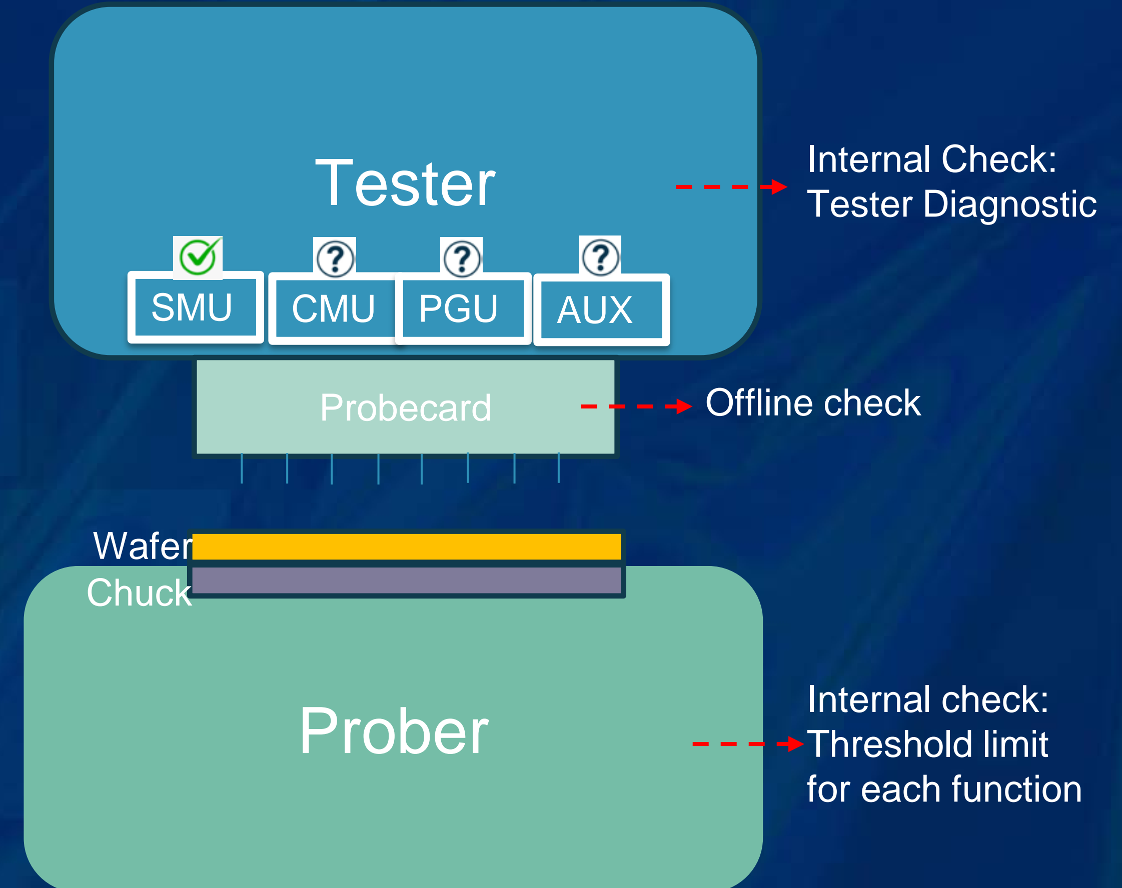
- **Shift Left / Preventive mindset at every run.**
- **Saving capacity and avoiding bad data generation.**

Limitation to CRES and Current Hardware Diagnostic

1. **CRES is not covering all tester resources and requires wafer.**

2. **Tester and Prober performed its own individual self-check, not as one single entity.**

Need new capability from Industry:
<u>Test Cell Integrated Self-Check</u>



Summary

- Multiplexing param test structures helped overcome scribe line real estate constraints.
- Inadvertently caused challenges in Parametric hardware troubleshooting.
- CRES is viable option but not the perfect solution.
- Future Test Cell need to be integrated, smart to self-diagnostic, always good when needed.

THANK YOU!

- **Credits & Acknowledgement:**
  Micron Technology : Dave Peterson, Randy Cleverly, Gary Southern, Salil Mujumdar, Low Kar Loong, Thiam Seng Yip.