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Test in Transition: An OSAT Perspective

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Test Landscape

- *Business Model*
  - *Foundry, Fabless & Fab Lite model*
  - *Test companies drive new tester investment*
  - *Larger fabless able to finance and invest*
  - *Small to mid fabless looking for solutions*
- *Technology*
  - *Applications in analog, RF, mixed signal*
  - *3D IC TSV + 2.5D / Silicon Interposer*

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Serving Customers for Test in Transition

Customers

ASE Japan
ASE Korea

ISE Labs, Inc.

ASE Chung Li
ASE Kaohsiung
ASE Shanghai
ASE Singapore
ASE Malaysia

Group Test R&D

☐ Sales and Representative Offices ☐ IC Service ☐ System Service

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Companies Looking for Total Test Solutions

- Turnkey solution
- Best fit and cost effective solutions
  Test Capacity
- Device characterization
  HW design and simulation
- Test time reduction
  Leverage Multiple Platf...
- Yield management
  Yield improvement

Total Test Solutions

Test Platform Strategy

Test HW & SW Development

Productivity & Efficiency

Test Transfer

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4C Expanding Landscape

Communication	*Computing*
• *Mobile Transceivers* • *Mobile Baseband/App. Processor* • *Wireless LAN/BT Transceiver/BB* • *Cordless phone Transceiver/BB* • *RF - Switch/PA/LNA/Tuner/FE* • *Wireless Module*	• *CPU/MPU/MCU/GPU* • *Application Processor* • *USB* • *PCI-E* • *SATA* • *Memory*
Consumer	***Car/Automotive***
• *LCD controller* • *HDTV/STB* • *TMDS/HDMI* • *Game console* • *BD/DVD R/RW controller* • *Video and Audio Codec* • *MCU* • *PMIC/LED.....*	• *Microcontroller* • *Car Multimedia controller* • *Radio/satellite tuner* • *Power/sensors* • *Engine controller* • *ABS controller* • *Throttle controller* • *Steering/brake …*

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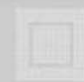

Example: Test for RF Module

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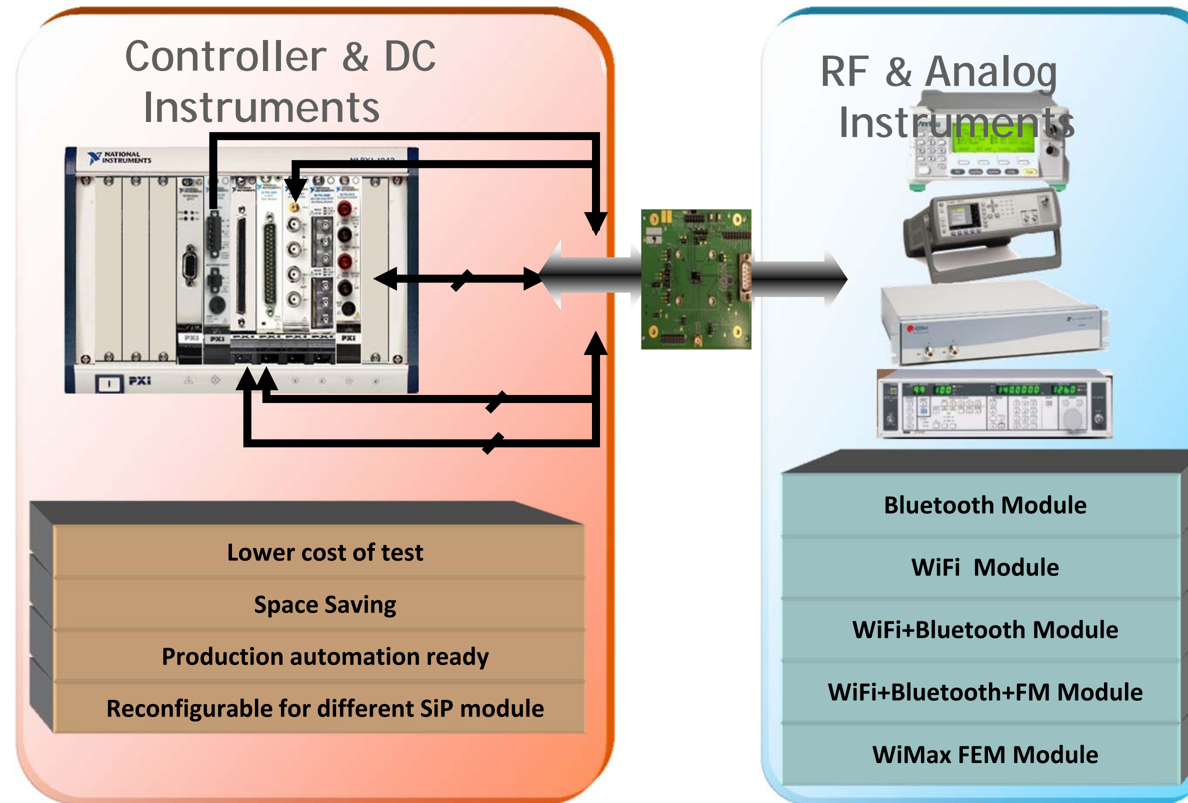
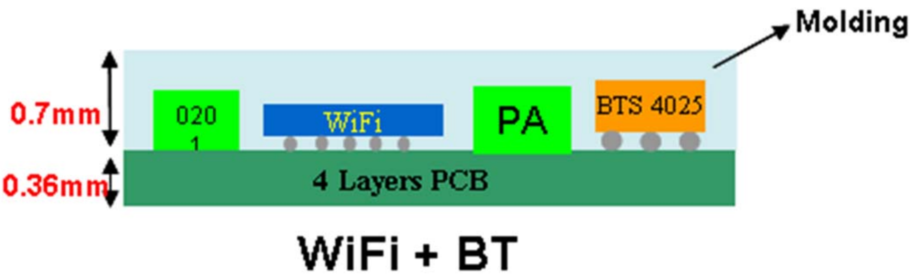
Wireless Connectivity Module

- **System level test**
  - *System like activity*
    - Interaction between DUT and tester
    - Protocol test
    - Bench setup or ATE?
  - *Cost of test*
    - One or Multi insertions?
    - Automation or manual?
    - Best multi-sites efficiency?





Type / Test time(s)	Manual	Automation x1	Automation x2	Automation x4	Automation x6	Example
10~20	Poor	Fair	Good	Excellent	N/A	Bluetooth, DVB
20~40	Fair	Poor	Fair	Good	Excellent	WiFi
40~100	Good	Poor	Poor	Fair	Good	WiFi
100 above	Excellent	Poor	Poor	Poor	Poor	GPS

Legend: Poor, Fair, Good, Excellent

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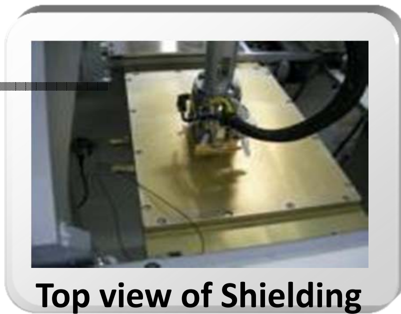
Production Test Integration

Low Cost Handler

6 SITES Automation

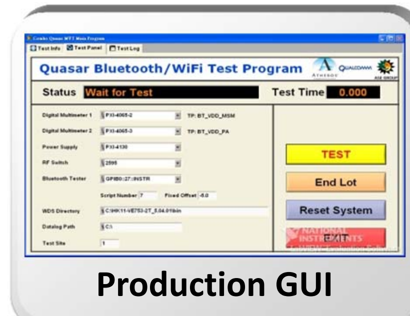
High-Throughput Automation
- ✓ Low cost handler
- ✓ 6 sites parallel testing


Top view of Shielding

Side view of Shielding

Shielding box for handler
- ✓ Lab certified
  - ✓ 80dB isolation for RS232
  - ✓ 70dB isolation for SDIO

PXI Test Controller



Production GUI

Test SW and HW
- ✓ Program development
- ✓ Test fixture design
- ✓ Test data analysis

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Example: Test for 3D

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3D/2.5D IC Business Model

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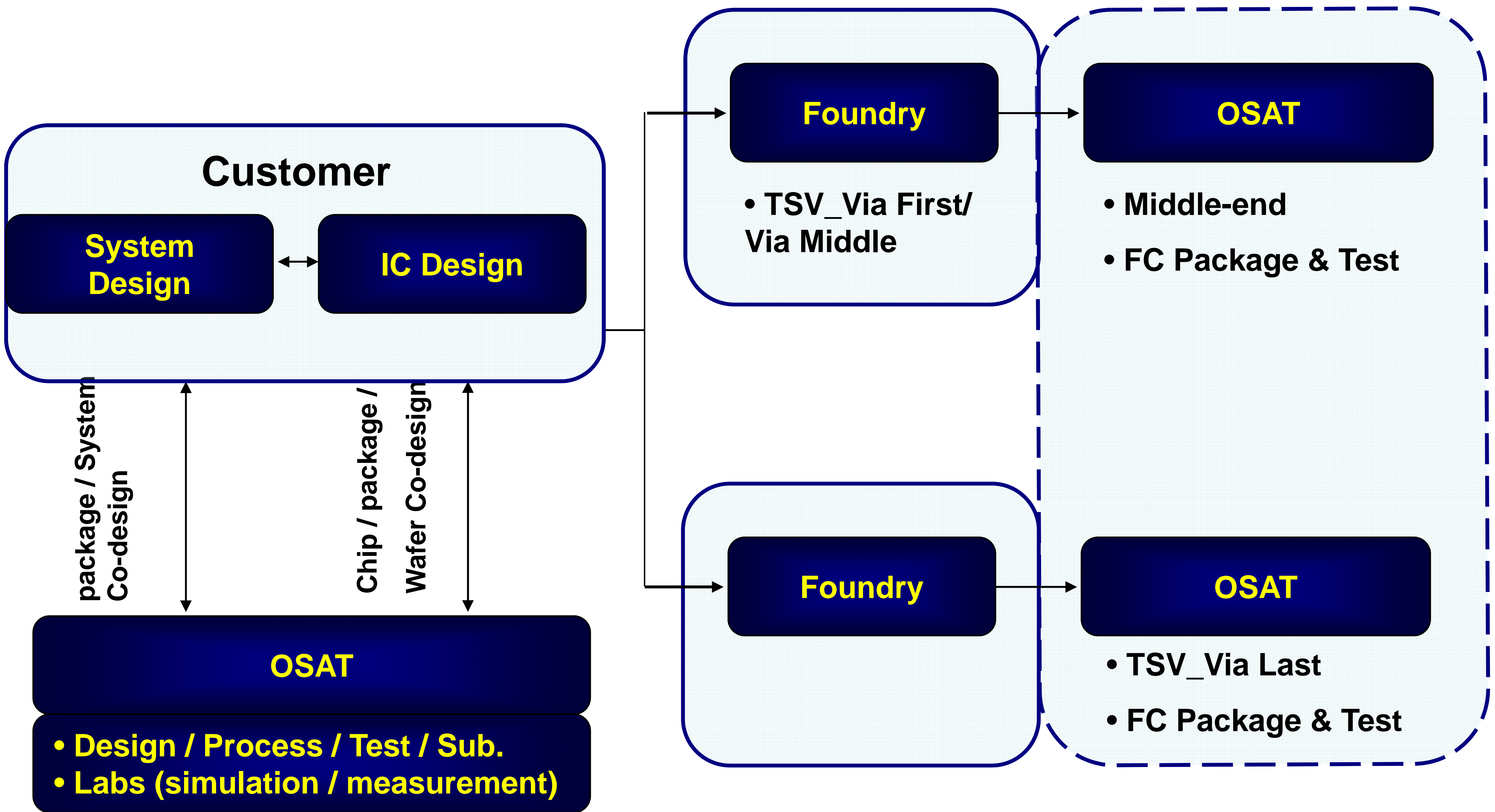

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3D IC Test Challenges

- Wafer Probing
  - Thinned wafer handling
    - Grinding before/after test
    - Assembly flow vs. Test
  - TSV test
    - TSV defect
    - Double-sided wafer probing?
  - Die/wafer contact interface material
    - Bond pads/ micro bumps/ TSV
    - Cu pillars
  - Contact force of high I/O number vs wafer thickness
    - Probe Force
    - Probe material
  - Fine Pitch
    - Area array pitch < 50um
    - > 1000 contacts

- Package Test
  - Heterogeneous cores
    - Logic + analog
    - Imbedded passive
    - Imbedded die
  - Test Methodologies
    - KGD fault coverage
    - New fault types
    - DFT
    - System Level test
  - Cost of test
    - One insertion/multi insertions
    - ATE or Customized Bench

Fundamental Study Capability Is Required Jointly between Assembly and Test

Joint Development among IC/Foundry/System/Assembly & Test

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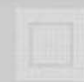

3D IC Test

Processor wafer

1. Processor Wafer (w/ Cu pillar bump)

carrier

2. Mount processor wafer onto Carrier

carrier

3. Middle-end Process

carrier

4. Release Processor Wafer from Carrier

5. Processor Wafer Dicing

Test

* 6. Processor die TC Bonding to Substrate

7. Memory die TC Bonding to Processor

8. Wafer Level Mold

est

9. Marking, Ball Mount & Singulation Saw

* Challenges in 3D IC Test from warpage control in test and assembly environment.

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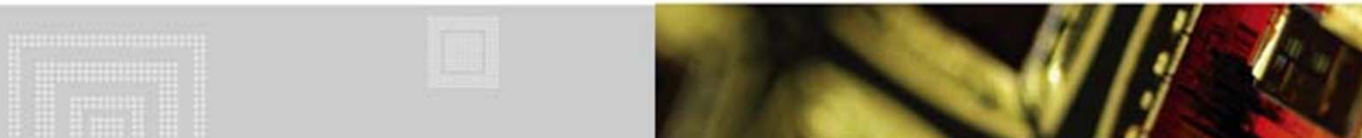

2.5D IC Test

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(a) TSV Etch

(b) Oxide/Barrier/Seed Layer Deposition

© Cu Plating

(d) Front-side Cu CMP

(e) RDL & FC Bumping

(f) Carrier Mounting

(g) Wafer Thinning

Test
(h) RDL & Micro-bumping

Test
(i) Film Frame Mount

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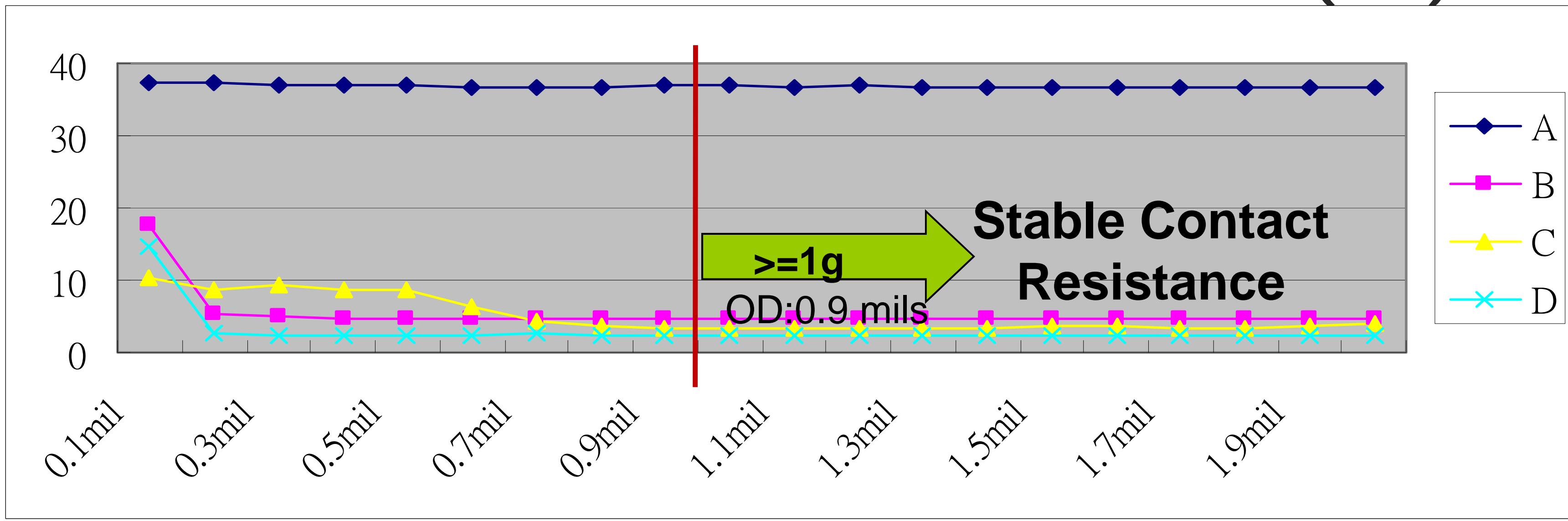
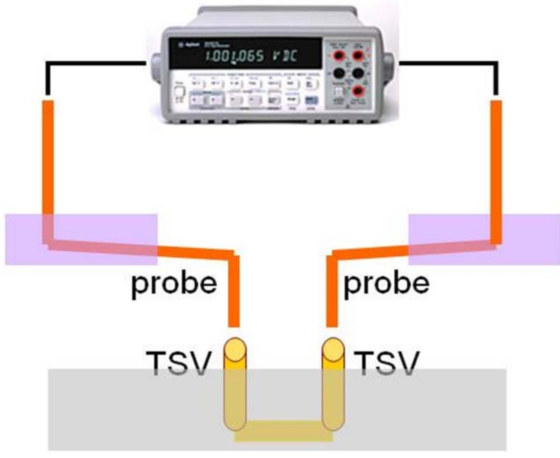
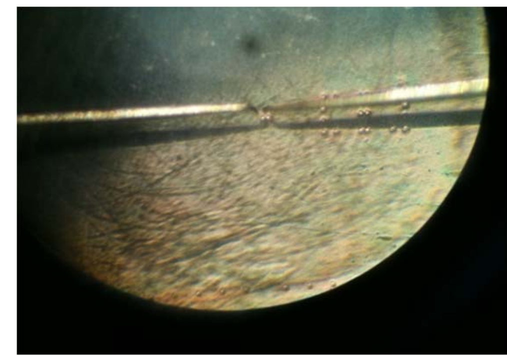
Fundamental TSV Contact Force Study

✓TSV resistance vs. contact force (OD)







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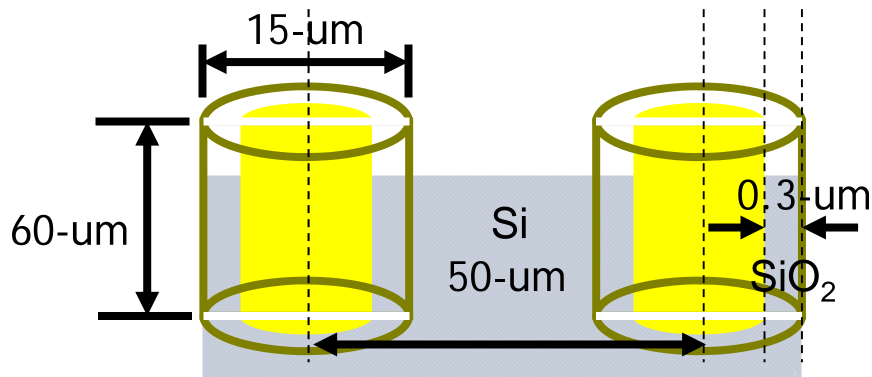
TSV Contact Force Study



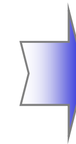
Contact Force >3g

TSV damage

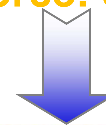
Contact Probe Force > 3 gr

OD:0.2 mils
Force: 0.3g

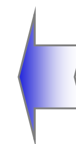
OD:1.5 mils
Force: 2.25g



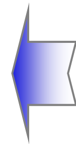
OD:2.0 mils
Force: 3.0g



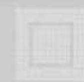
OD:2.1 mils
Force: 3.15g



OD:2.3 mils
Force: 3.45g



OD:2.5 mils
Force: 3.75g



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Probe Design Challenges

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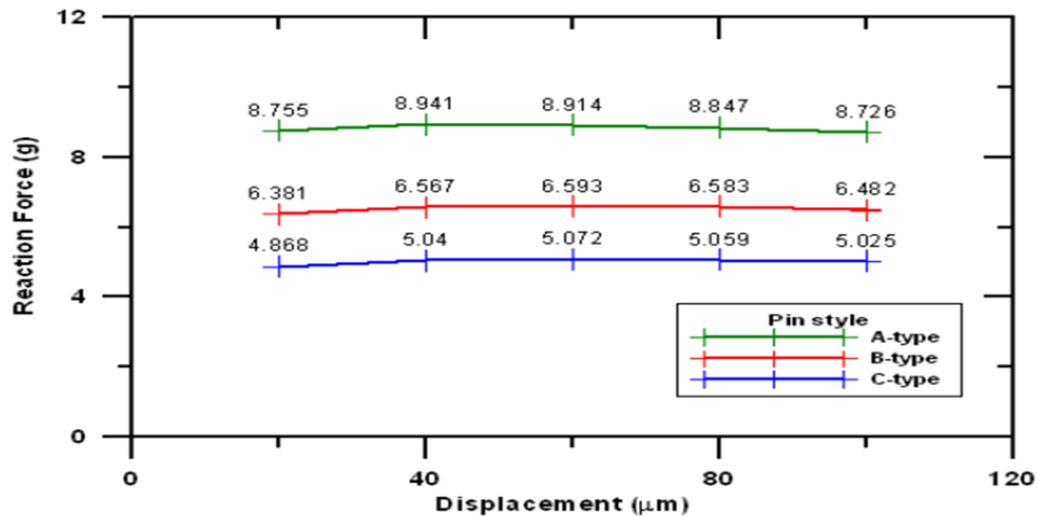
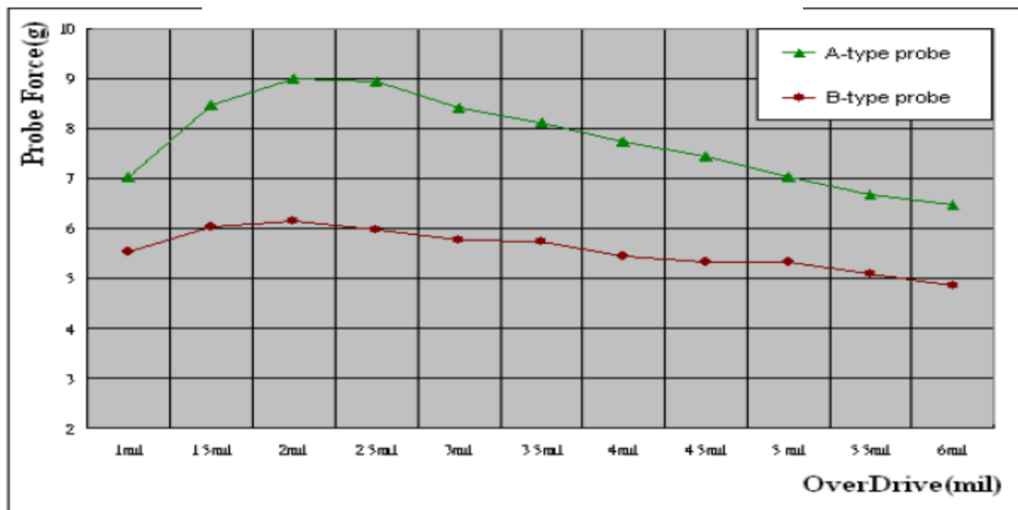
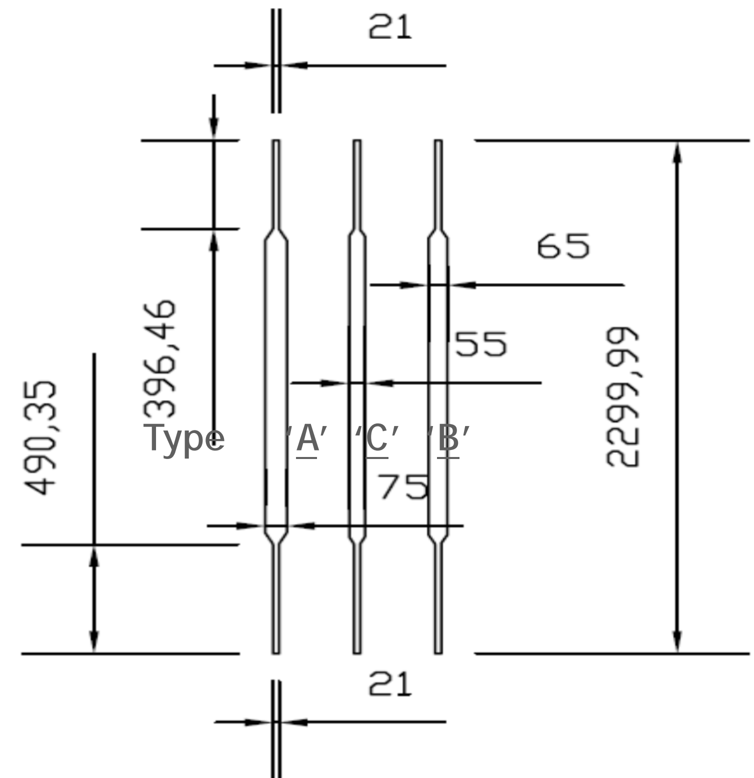
Reaction Force Simulation



Actual Gram Measurement





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Summary

- *Industry in transition*
- *Test is a critical element in supply chain*
- *Dynamic business model to support changing landscape and advancing technology*

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