Diagnosis of Sequence Dependent Chips

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Bio
B.S.E.E., National Taiwan University, 1993.
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Sequence Dependence

- Test results depend on test pattern ordering
- NAND with Stuck Open Fault (SOF) T1
  - \( AB=\{00,11,01\}, \ Z=\{1,0,0\} \), detected
  - \( AB=\{00,01,11\}, \ Z=\{1,1,0\} \), not detected

Charges stored at \( Z \)

\[
\begin{array}{c|c|c|c}
\text{AB} & 00 & 01 & 10 \\hline
\text{Z} & 1 & 1 & 1 \\
\end{array}
\]

NAND Truth Table
The “Murphy Test Chip”

- Test chip description [Franco 95]
  - 0.7µm technology, 5V nominal $V_{DD}$
  - 25K gates, combinational circuits
- 5 designs: 2 data path, 3 control Logic
- 5.5K chips tested

```
Label		Count
---
TIC		116
  SSF		66
    41
  Non-SSF	25
    39
  Timing Dependent	50
    11
  Sequence Dependent

```
Diagnosis Flow

1. Test
   - Failure Traces
2. SSF Diagnosis
   - Diagnosed SSF faults
3. SSF Fault Simulation
   - Fault Signatures (SSF)
4. Post Processing*
   - Fault Signatures (SOF)
5. Matching
   - Diagnosis results

* Details see [Li VTS'02]
Diagnosis Results

11 Sequence Dependent Chips

<table>
<thead>
<tr>
<th>Chip ID</th>
<th>Perfect match?</th>
<th>Diagnosed faults</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD.1-7</td>
<td>Y</td>
<td>1 SOF</td>
</tr>
<tr>
<td>SD.8</td>
<td>Y</td>
<td>1 SSF + 1 SOF</td>
</tr>
<tr>
<td>SD.9</td>
<td>N</td>
<td>2 SSF + 1 SOF</td>
</tr>
<tr>
<td>SD.10,11</td>
<td>N</td>
<td>unknown</td>
</tr>
</tbody>
</table>

- **Chip #8, 9**
  - Clustered defects ➔ multiple faults
- **Chip #10,11**
  - Library cell modeling issue?
Summary

• Stuck open fault
  ◆ Sequence dependence

• 5.5 K Murphy chips tested
  ◆ 116 defective chips
    ■ 11 sequence dependent
      ■ 7 single stuck-open fault
      ■ 2 SSF + stuck-open fault
Other Sequence Dependent Chips

- Multiple faults [Li VTS’02]
  - Clustered defects [Koren 94]

Wafer map