DesignConEast 2005
Track 6: Board and System-Level Design (6-WA2)

“Connector-Less Probing: Electrical and Mechanical Advantages”

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Objective

1) Describe Differences between Connector-less and Connector-Based Probing

2) Aid in Selection of Logic Analyzer Probe
The Logic Analyzer

- A logic analyzer is a piece of general purpose, test equipment
- It provides debug/validation for digital systems
- It is connected to the target system using a probe
The Probe

- Provides the “electrical” connection from the target to the analyzer
- Provides the “mechanical” connection from the target to the analyzer
- Both are important factors in selecting a probe
Probe Theory

• The Probe Passively Observes the Target Signal
• A Small Amount of the Target Signal Enters the Probe
• The Logic Analyzer Amplifies this Signal to see the Original Waveform
Probe Theory

• The Probe Can Be Thought of as a “Resistive Divider Network”

Divider Ratio
Probe Theory

• The Goals of the Probe are to:

  1) Do Not Disturb the Target Signal

  2) Accurately Represent the Original Signal Within the Analyzer
Probe Implementation

• The physical implementation dictates probe performance

**Tip Resistor**
- Discrete SMT
- Discrete Coaxial

**Cable**
- Coax
- Twisted Pair

**Termination/Amp**
- Custom Circuitry

**Interconnect**
- Wires
- Connectors
- Springs
Probe Loading

- What does the user need to be concerned about?
  1) DC Loading
  2) AC Loading
  3) Meeting Analyzer Specs at Probe Tip

“The Probe Tip”


Probe Loading

• What does the User Need to be concerned about?

  1) DC Loading - dictated by “Tip Resistor” value

    • DC – 500Mb/s  = 100MΩ’s (less DC Loading)
    • > 500Mb/s    = 20kΩ’s (more DC Loading)
Probe Loading

• What does the User Need to be concerned about?

2) AC Loading - dictated by “Interconnect” & “Location on Bus”

• Further from Target = More Capacitive Loading (stubs)
• Poor Bus Location = Distorted Waveform (analyzer failures)
Probe Loading

• What does the User Need to be concerned about?

3) Meeting Analyzer Specs at the Probe Tip

• Defined WITH PROBE CONNECTED!!!
• Depends on Loading and Location on Bus
Traditional Probing

• Probing Methodologies

1) Designed-In

- User Plans Ahead
- Places Footprint on Target
- Routes Signal of Interest to Footprint

ex) High-Density Connectors
Pin-Header Strips
Traditional Probing

• Probing Methodologies

2) After-Thought

- Signal NOT routed to test pad

ex) Solder Down Accessories, Grabbers, Browsers
Traditional Probing

• Limitations

1) Physical Interconnect Loading

- Electrical and Mechanical Connection are the Same which increases size

- Increased Size means more loading (L and C)
Traditional Probing

• Limitations

2) Designed In Connectors Block Routing

- Connector Holes are Often Obtrusive to Flow-Through Routing
- Connectors are placed off to the side and stubs are used to connect
Traditional Probing

- Limitations

3) Tip Resistor is Far from Target

- Increased Capacitive Loading (Stub)
Connector-Less Probing

• Probing Methodology

1) Small Test Pads are Placed on the Target

- Signals of interest are routed to the pads
Connector-Less Probing

- Probing Methodology

  2) A Retention Module is Hand Soldered to the PCB

  - The RM pins are the Mechanical Connection *ONLY*
Connector-Less Probing

Probing Methodology

3) Attach Compression Probe to RM
- The compression interconnect contacts the pads
- The RM aligns and retains the interconnect
- The compression interconnect is the Electrical Connection ONLY
Connector-Less Probing: Electrical Advantages

1) Reduced Loading

- The physical size is smaller than a connector
- The Mechanical and Electrical Connections are Separate

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value 1</th>
<th>Value 2</th>
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<tbody>
<tr>
<td>Loading</td>
<td>3pF</td>
<td>&lt;0.7pF</td>
</tr>
<tr>
<td>Datarate</td>
<td>600Mb/s</td>
<td>&gt;2.5Gb/s</td>
</tr>
</tbody>
</table>
2) Flow-Through Routing

- The Small Test Pads Allow Signals to route through the footprint

- No Stubs Needed
- Differential Spacing Preserved
3) Tip Resistor is Closer to the Target Signal
   - Reduced loading due to parasitic stub

Loading:    3pF   <0.7pF
Datarate:   600Mb/s  >2.5Gb/s
Connector-Less Probing: Electrical Advantages

Connector-Based vs. Connector-Less
(Mictor vs. SoftTouch)

- SPICE Simulation of Reflections from Probe
- 50Ω System
- Double Terminated
- Probing in Middle of Bus

TDR SPICE Simulation

Rise time = 175ps = 2GHz
Rise time = 117ps = 3GHz
Rise time = 88ps = 4GHz
Rise time = 70ps = 5GHz
Rise time = 58ps = 6GHz
Connector-Less Probing: Electrical Advantages

Connector-Based vs. Connector-Less
(Mictor vs. SoftTouch)

- SPICE Simulation of Transmission Degradation from Probe
- 50Ω System
- Double Terminated
- Probing in Middle of Bus

![TDT SPICE Simulation](image)

Rise time = 175ps = 2GHz
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Connector-Less Probing: Electrical Advantages

Connector-Based vs. Connector-Less
(Mictor vs. SoftTouch)

- SPICE Simulation of Differential Separation Caused from connector-based probe
- 100Ω System
- Double Terminated
- Probe in Middle of Bus
- PC5 uStrip Decoupled for 1”

Impedance Mismatch due to Uncoupling of Diff Pair
Connector-Less Probing: Electrical Advantages

Connector-Based vs. Connector-Less

- Historical View


First Logic Analyzer  “3M” 40-pin 3pF loading 500Mb/s  “Mictor” 3pF loading 600Mb/s  “Samtec” 1.5pF loading 1500Mb/s  Soft Touch <0.7pF loading >2500Mb/s  Flying Leads 0.9pF loading 1500Mb/s ½ Size Soft Touch <0.7pF loading >2500Mb/s Soft Touch Pro <0.7pF loading >2500Mb/s


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Connector-Less Probing: Mechanical Advantages

1) Ease of Assembly

2) Mechanical Reliability

3) Post-Production Probing
Connector-Less Probing: Mechanical Advantages

1) Ease of Assembly

- RM is hand-soldered
- No Machine Loading Needed
Connector-Less Probing: Mechanical Advantages

2) Mechanical Reliability

- Spring-Pin Interconnect outperforms Standard Connectors

Planarity

Contamination
Connector-Less Probing: Mechanical Advantages

3) Post Production Probing

- RM can be hand-loaded on production units
So, what do these advantages mean to you???

Connector-Less Probes save you:

• Debug capability in high volume production PCB’s is FREE!
• No rework cost for damaged debug connectors
• Longer life out of Connector-Less probe adapters
• Debug PCB’s in the field for much lower cost
Summary

1) Connector-Less is the latest Technology in Logic Analyzer Probing

2) Connector-Less Probing has Improved Electrical Characteristics
   - Lower Loading, Faster Analyzer Datarates, Cleaner Routing of Signals

3) Connector-Less Probing has Improved Mechanical Characteristics
   - No Connector on Target PCB, Easy Attachment, Reliability, Cost Savings
Questions?