"Connector-Less Probing: Electrical and Mechanical Advantages"

Authors/Presenters: Brock LaMeres, Agilent Technologies
Brent Holcombe, Agilent Technologies
George Marshall, Precision Interconnect
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”
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

Agilent Technologies
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 $= 100\Omega$’s (less DC Loading)
  • $> 500\text{Mb/s}$ $= 20\Omega$’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>Loading</th>
<th>3pF</th>
<th>&lt;0.7pF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datarate</td>
<td>600Mb/s</td>
<td>&gt;2.5Gb/s</td>
</tr>
</tbody>
</table>
Connector-Less Probing: Electrical Advantages

2) Flow-Through Routing

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

- No Stubs Needed
- Differential Spacing Preserved
Connector-Less Probing: Electrical Advantages

3) Tip Resistor is Closer to the Target Signal
   - Reduced loading due to parasitic stub

<table>
<thead>
<tr>
<th>Loading</th>
<th>3pF</th>
<th>&lt;0.7pF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datarate</td>
<td>600Mb/s</td>
<td>&gt;2.5Gb/s</td>
</tr>
</tbody>
</table>
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

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 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

1973 - First Logic Analyzer
"3M" 40-pin 3pF loading 500Mb/s

1985 - "Mictor"
3pf loading 600Mb/s

1996 - "Samtec"
1.5pf loading 1500Mb/s
Soft Touch <0.7pf loading >2500Mb/s

2000 - Flying Leads
0.9pf loading 1500Mb/s

2003 - ½ Size Soft Touch
<0.7pf loading >2500Mb/s

2004 - Soft Touch Pro
<0.7pf loading >2500Mb/s

½ Size Soft Touch

Industry Standard Footprint
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

![Image of connector showing planarity and 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?