# 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

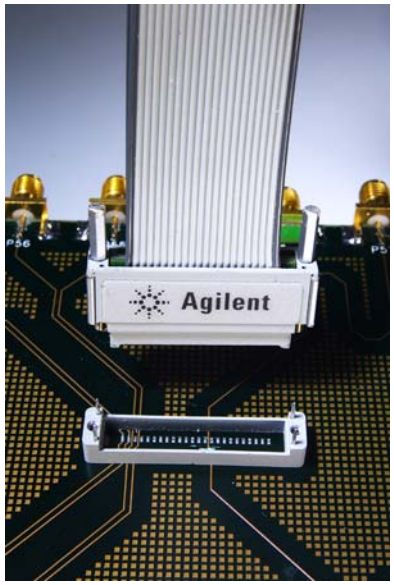
2) Aid in Selection of Logic Analyzer Probe

# 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

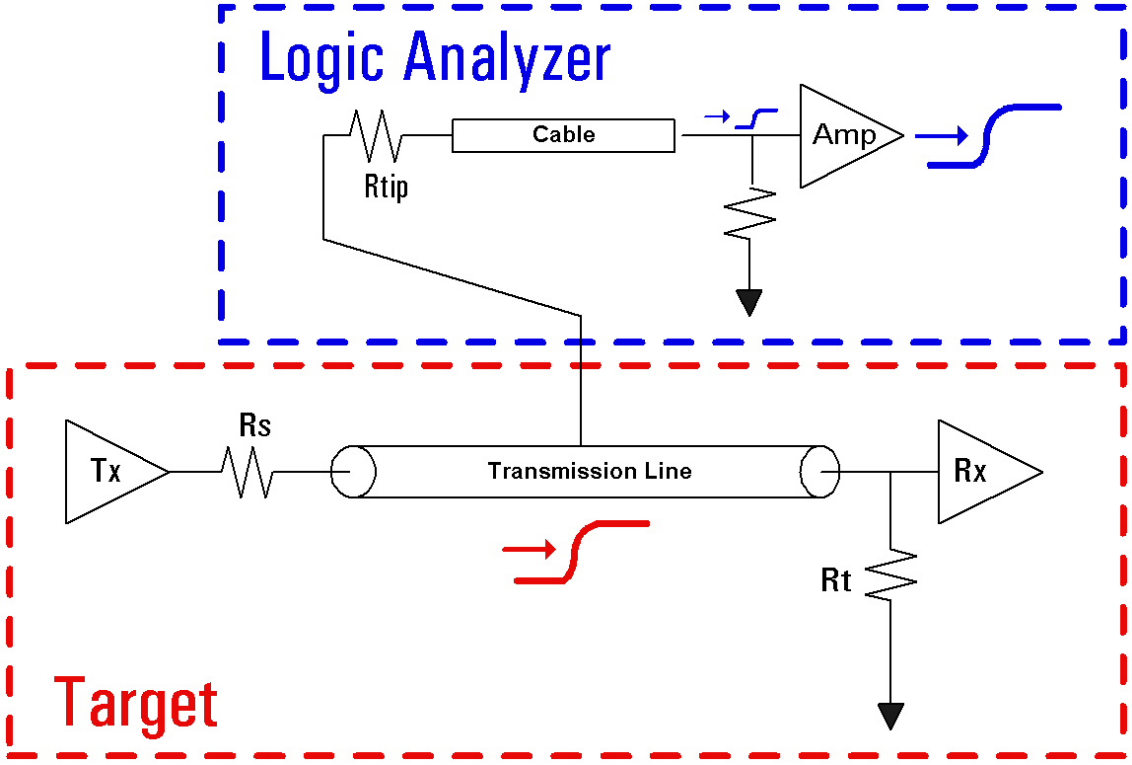
# The Probe

- 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

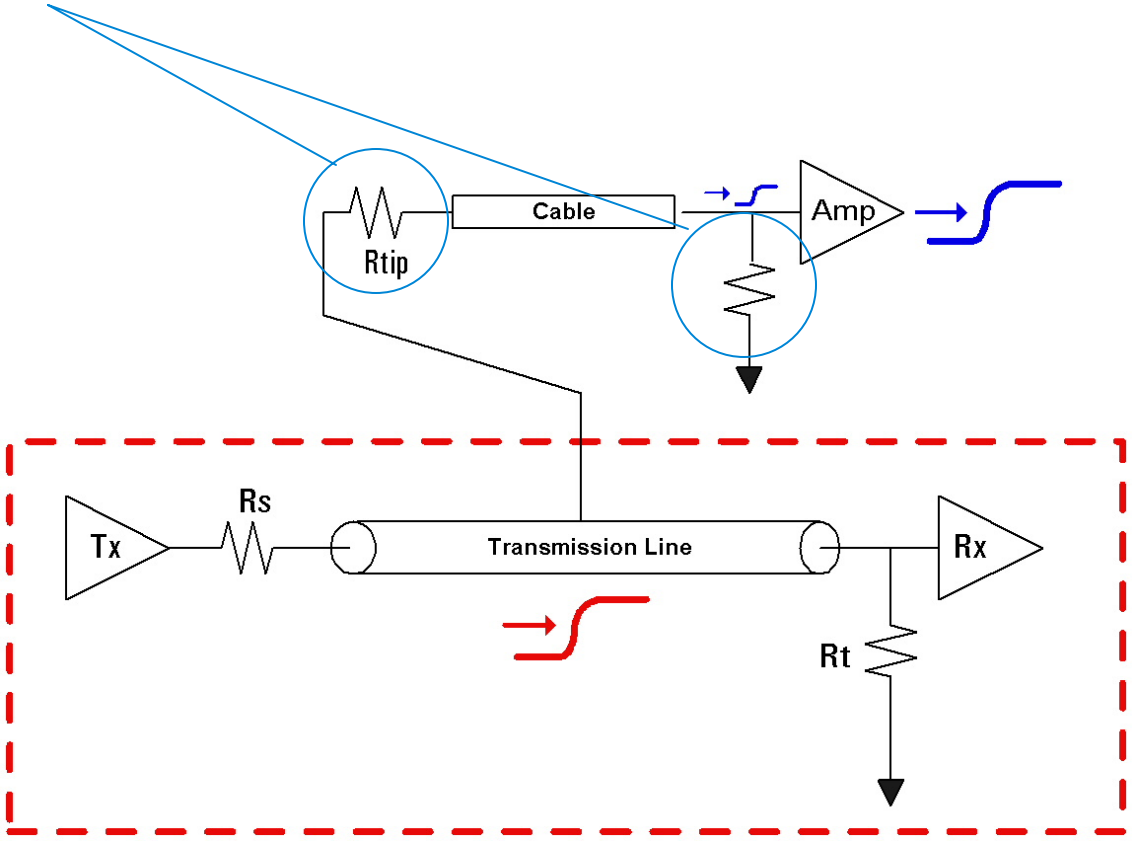
- The Probe Passively Observes the Target Signal
- A Small Amount of the Target Signal Enters the Probe
- The Logic Analyzer Amplifies this Signal to see the Original Waveform



# Probe Theory

- **The Probe Can Be Thought of as a "Resistive Divider Network"**

## Divider Ratio

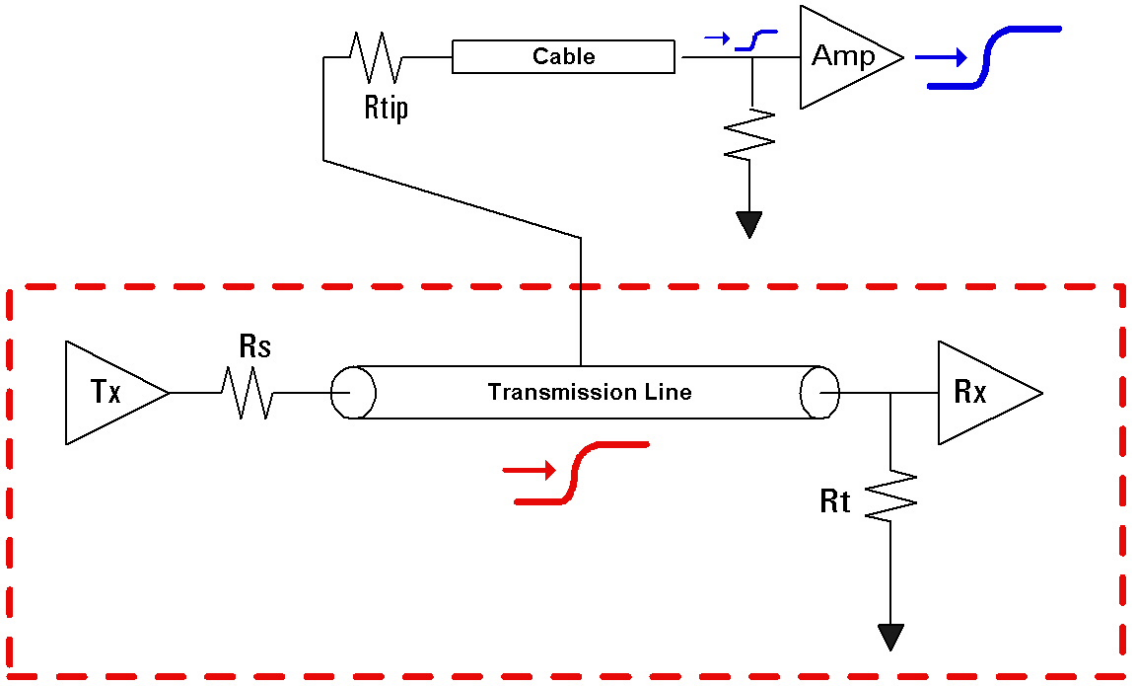


# Probe Theory

- **The Goals of the Probe are to:**

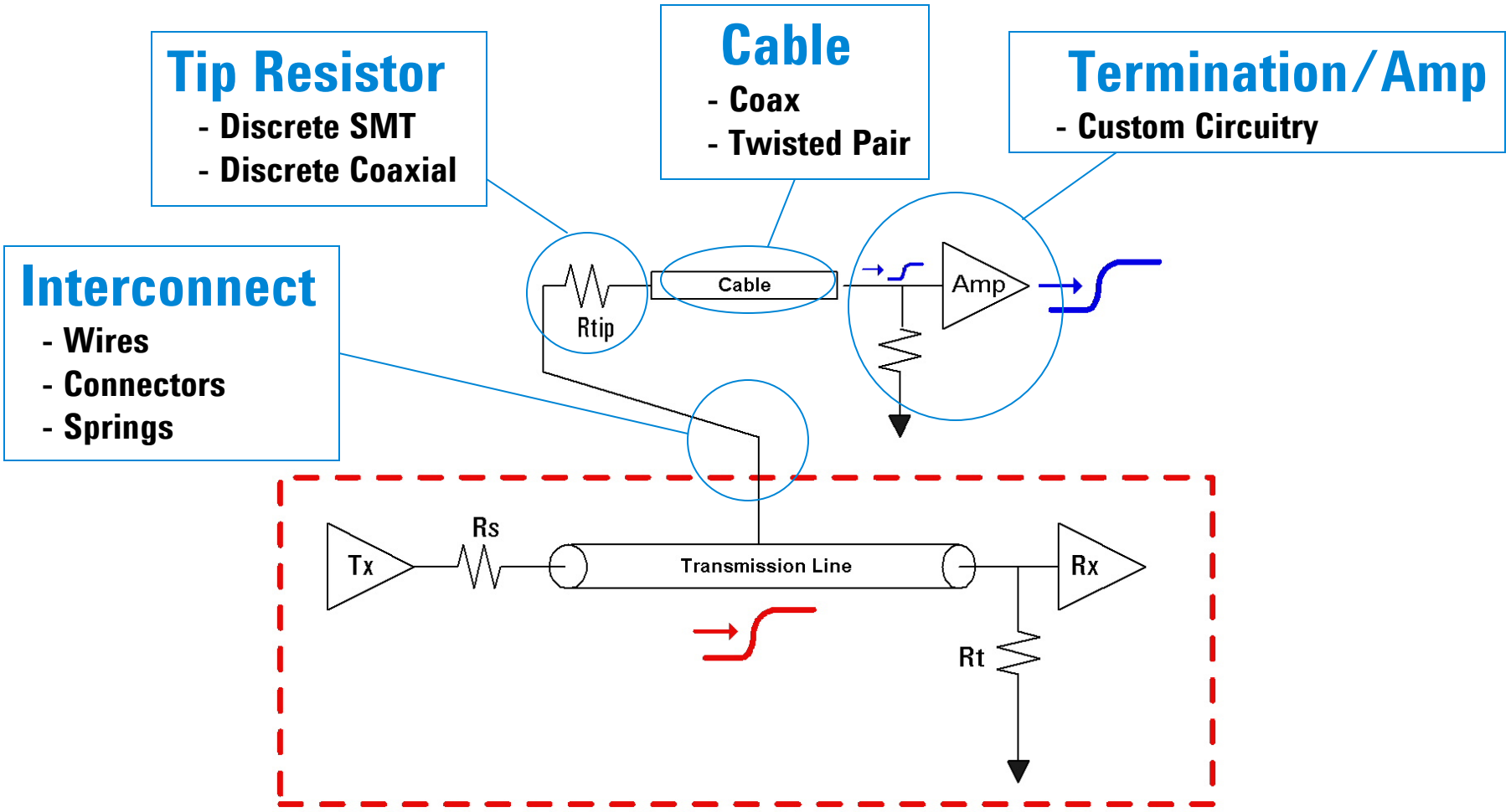
## 1) Do Not Disturb the Target Signal

## 2) Accurately Represent the Original Signal Within the Analyzer



# Probe Implementation

- **The physical implementation dictates probe performance**



# Probe Loading

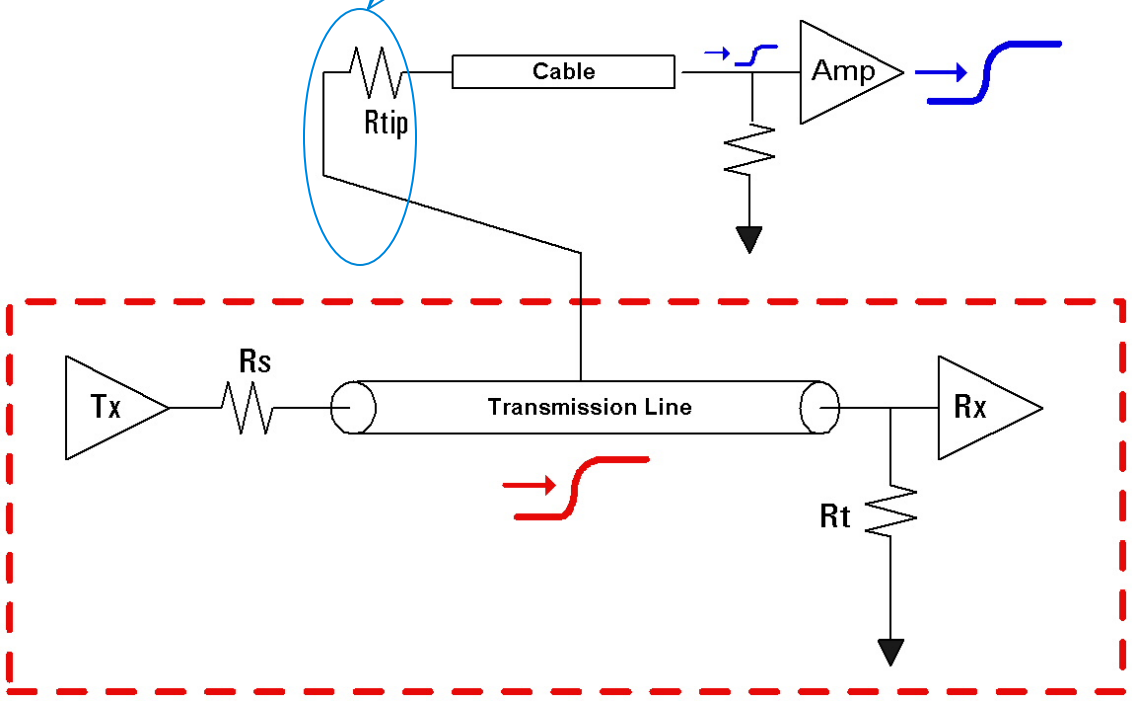
- **What does the user need to be concerned about?**

**"The Probe Tip"**

**1) DC Loading**

**2) AC Loading**

**3) Meeting Analyzer Specs at Probe Tip**

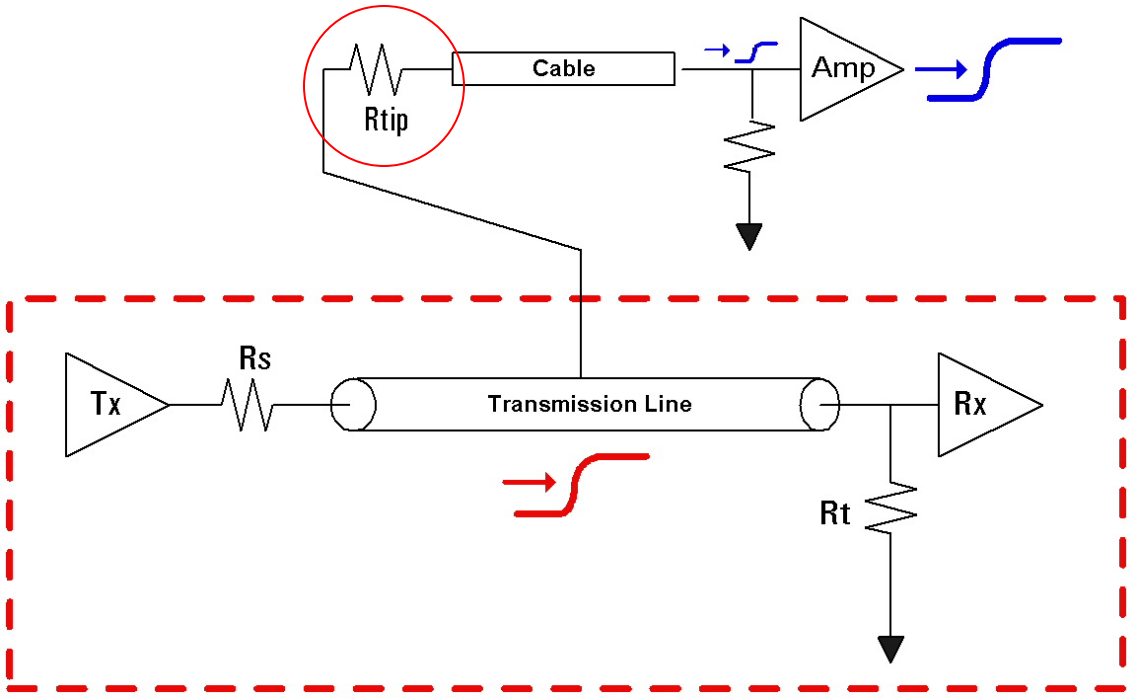


# Probe Loading

- **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)**

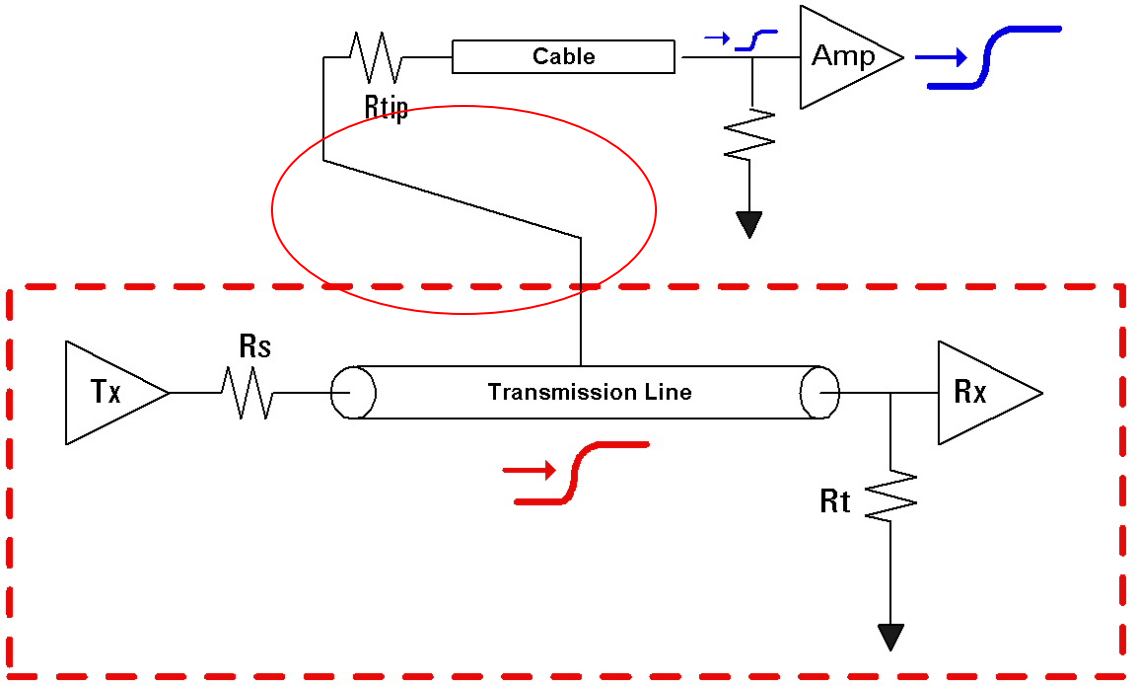


# Probe Loading

- **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)**

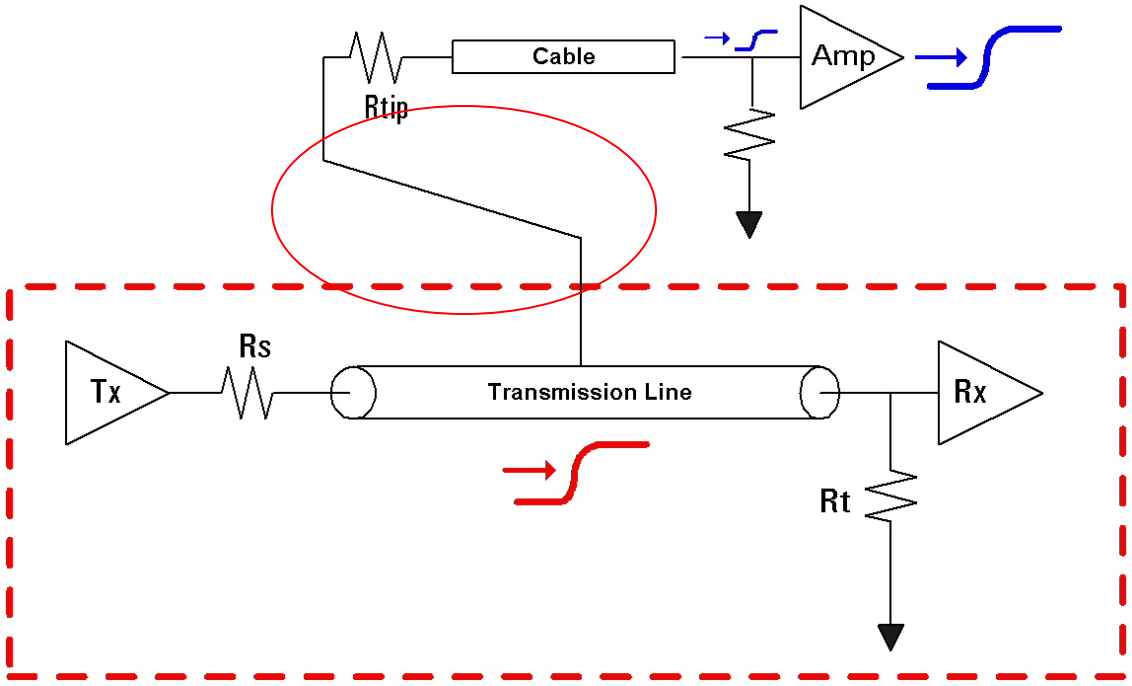


# Probe Loading

- **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

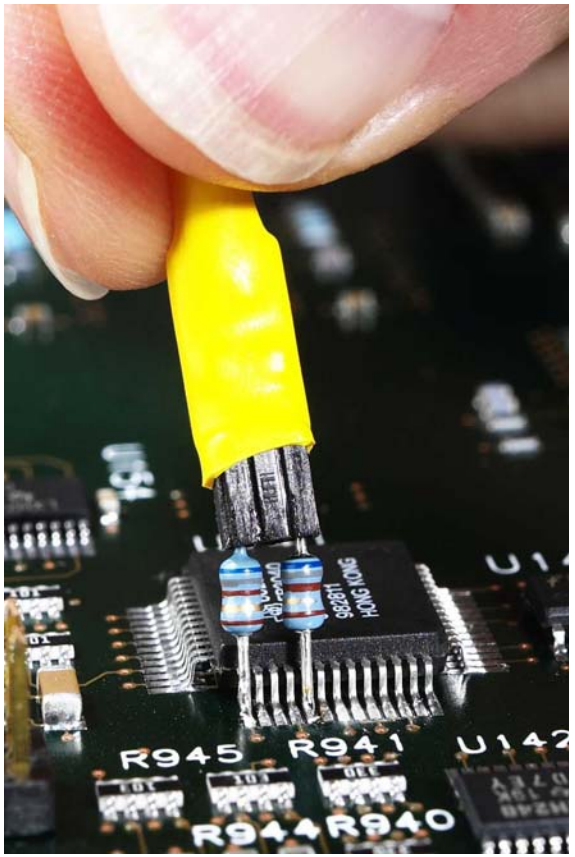
# Traditional Probing

- **Probing Methodologies**

  **2) After-Thought**

  - Signal NOT routed to test pad

ex) Solder Down Accessories,
Grabbers, Browsers



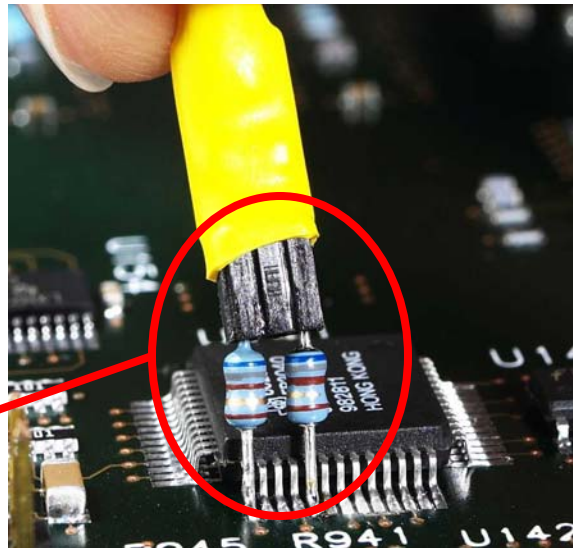
# Traditional Probing

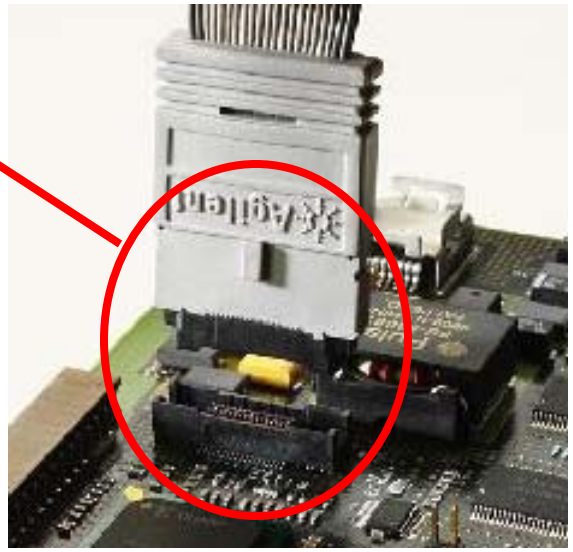
- **Limitations**

## 1) Physical Interconnect Loading

- Electrical and Mechanical Connection are the Same which increases size

- Increased Size means more loading (L and C)



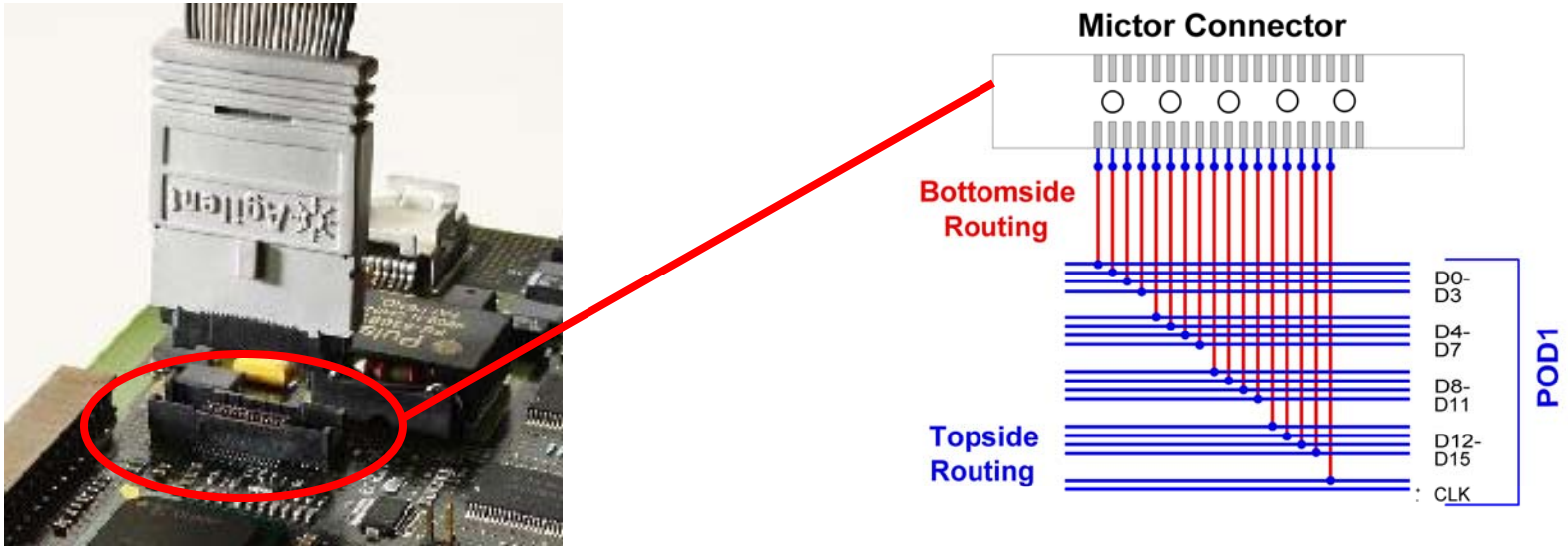


# Traditional Probing

- **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

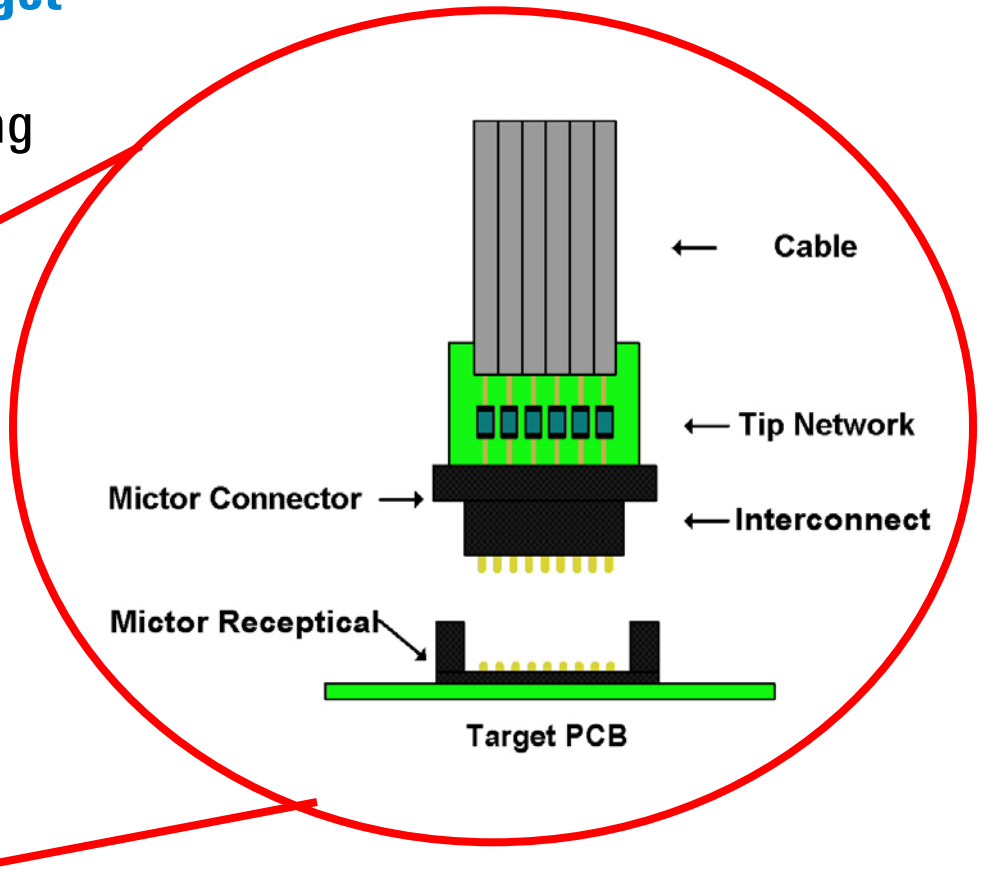


# Traditional Probing

- **Limitations**

## 3) Tip Resistor is Far from Target

- Increased Capacitive Loading (Stub)

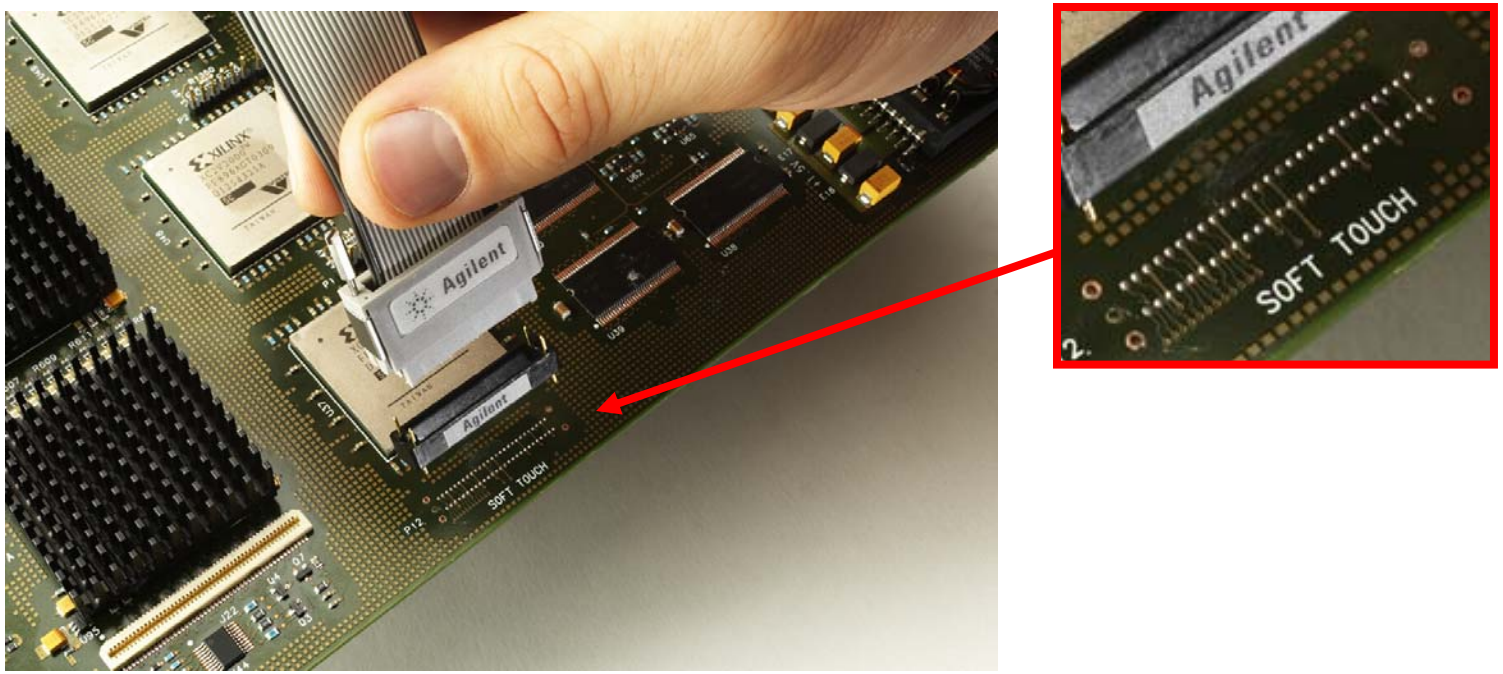


# Connector-Less Probing

- **Probing Methodology**

## 1) Small Test Pads are Placed on the Target

- Signals of interest are routed to the pads

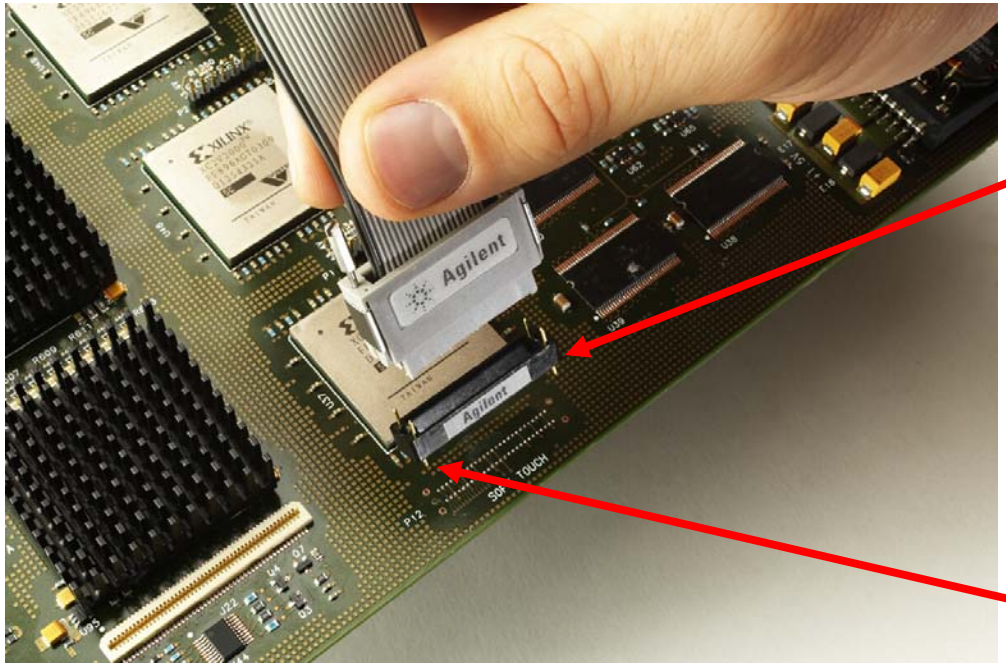


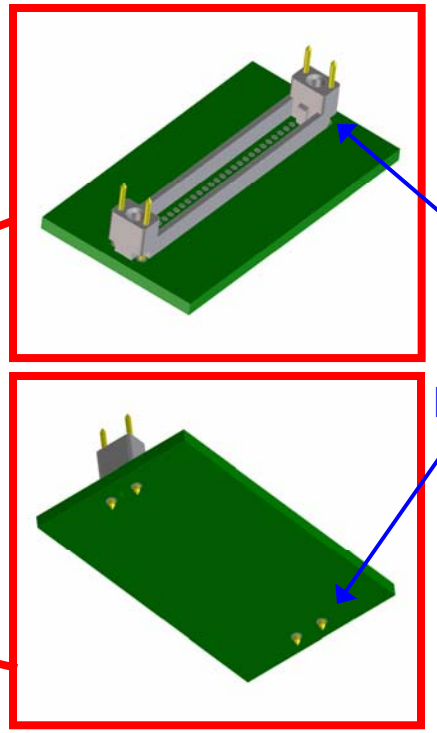
# Connector-Less Probing

- **Probing Methodology**

## 2) A Retention Module is Hand Soldered to the PCB

- The RM pins are the Mechanical Connection *ONLY*



Topside

Or

Bottomside

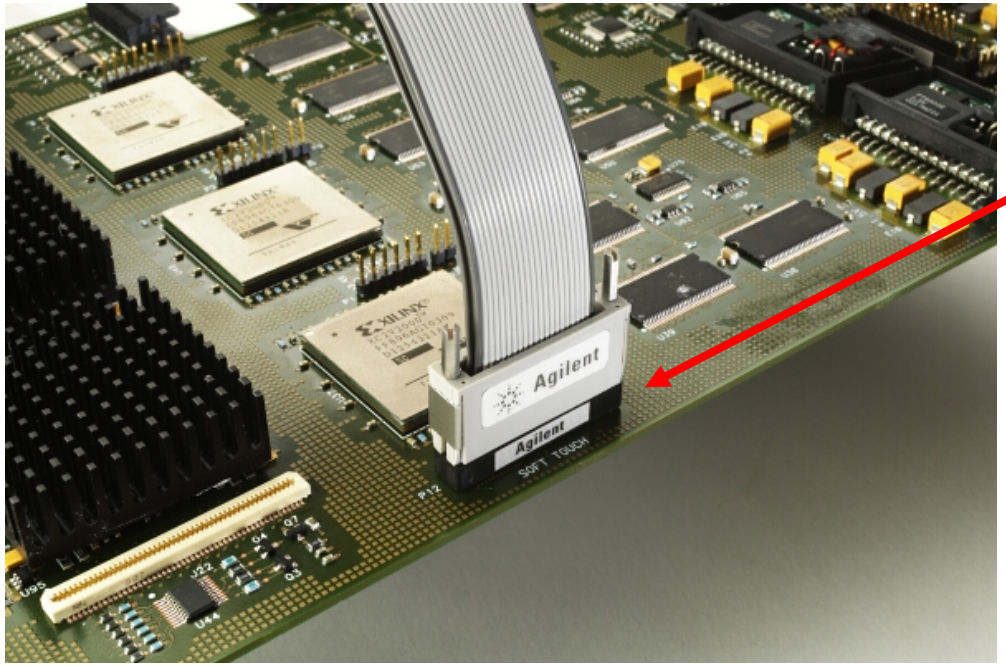
Solder

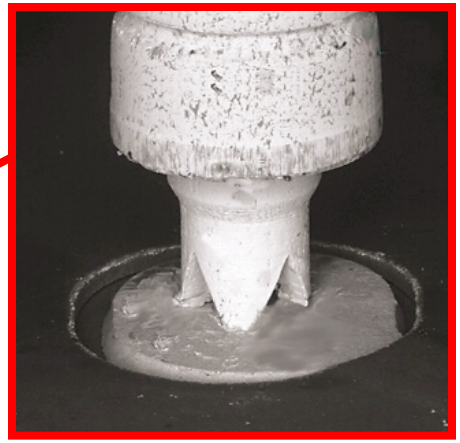
# Connector-Less Probing

- **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*

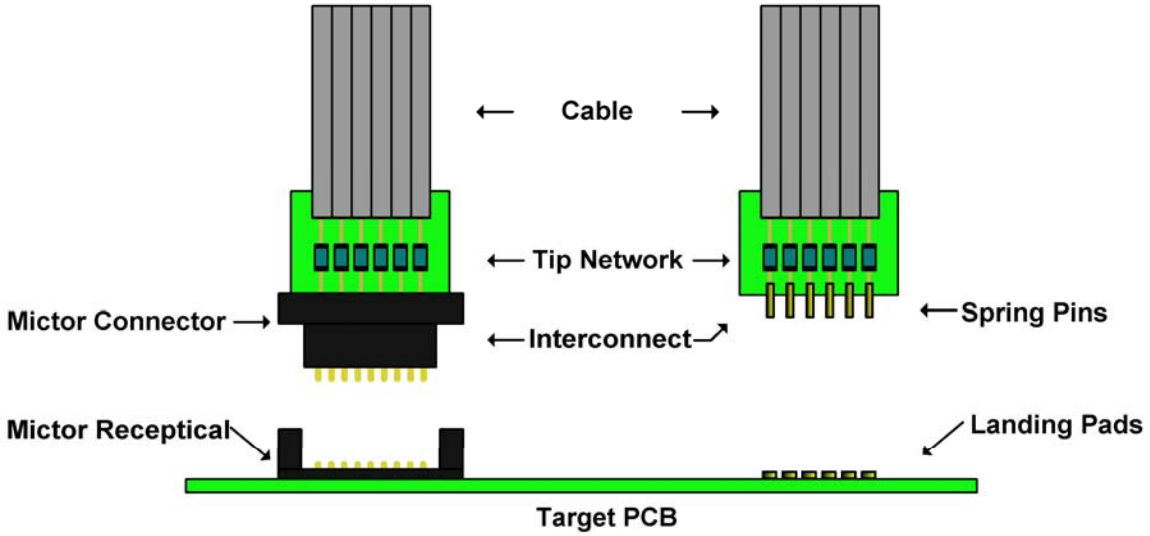


# Connector-Less Probing: Electrical Advantages

## 1) Reduced Loading

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



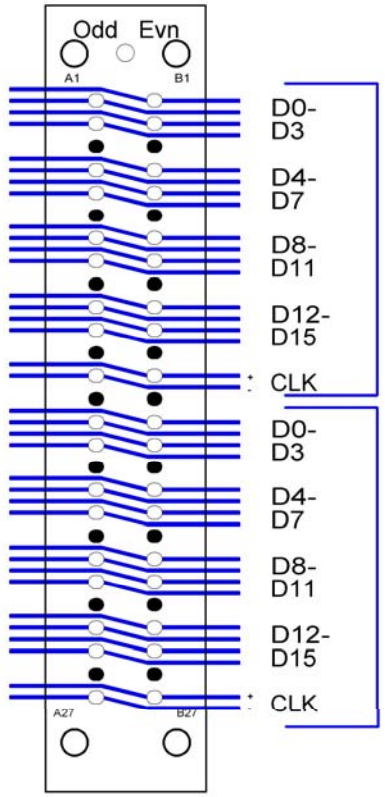

**Loading:** 3pF <0.7pF

**Datarate:** 600Mb/s >2.5Gb/s

# Connector-Less Probing: Electrical Advantages

## 2) Flow-Through Routing

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

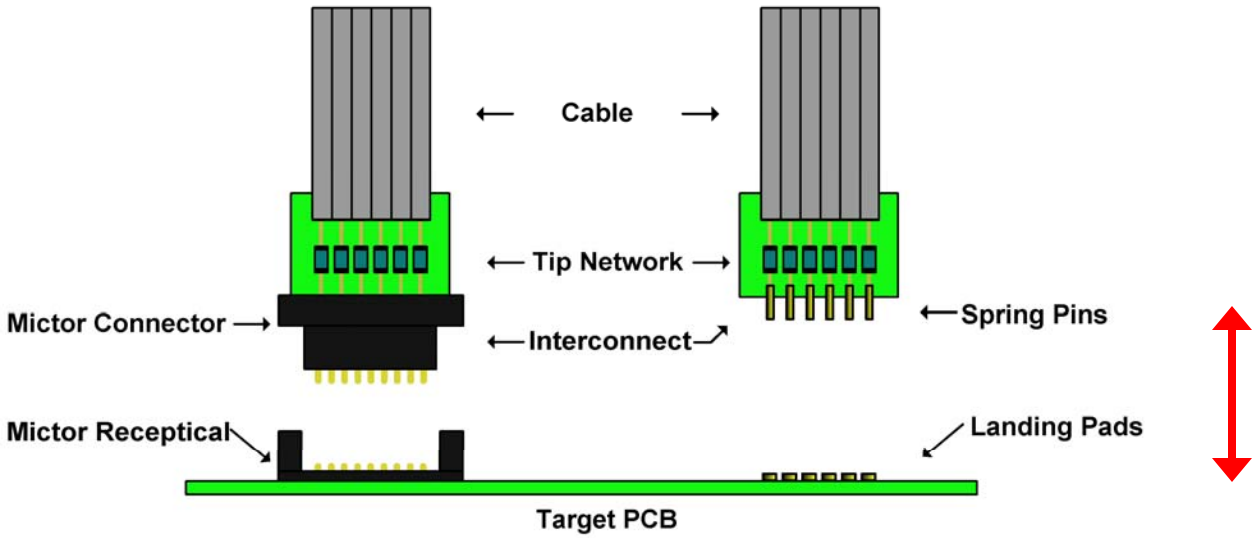



- No Stubs Needed
- Differential Spacing Preserved

# Connector-Less Probing: Electrical Advantages

## 3) Tip Resistor is Closer to the Target Signal

- Reduced loading due to parasitic stub



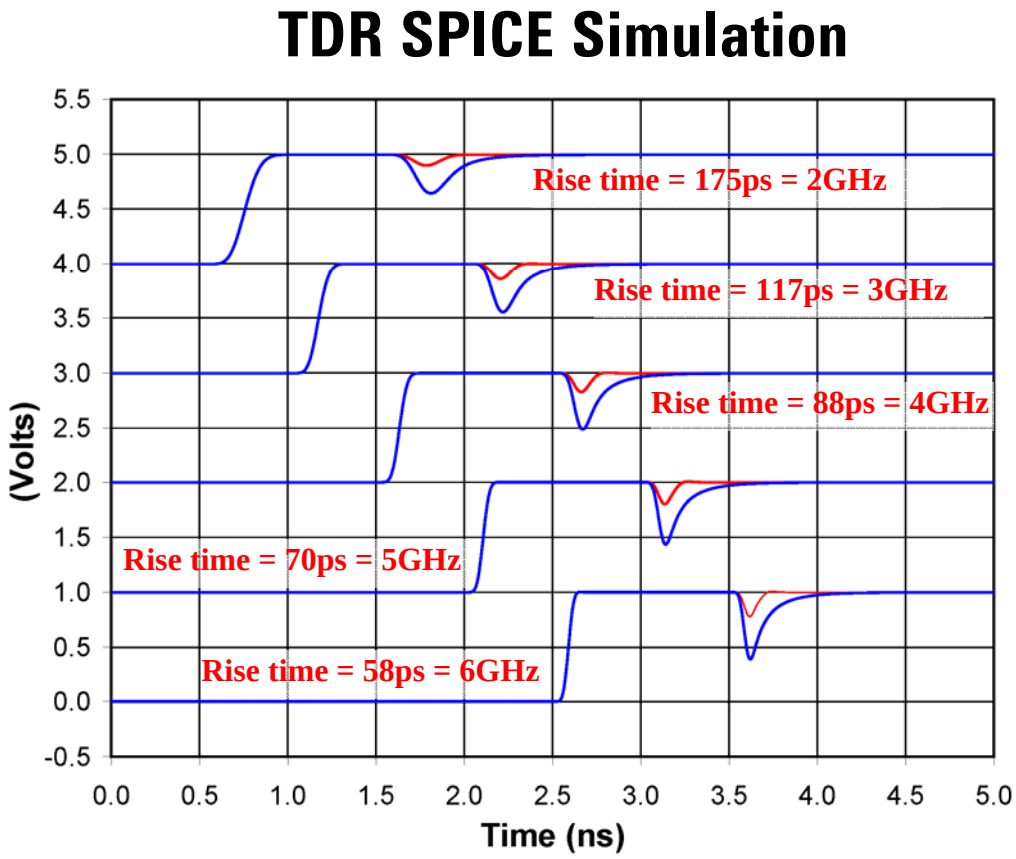

| | | |
|---|---|---|
| **Loading:** | **3pF** | **<0.7pF** |
| **Datarate:** | **600Mb/s** | **>2.5Gb/s** |

# 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

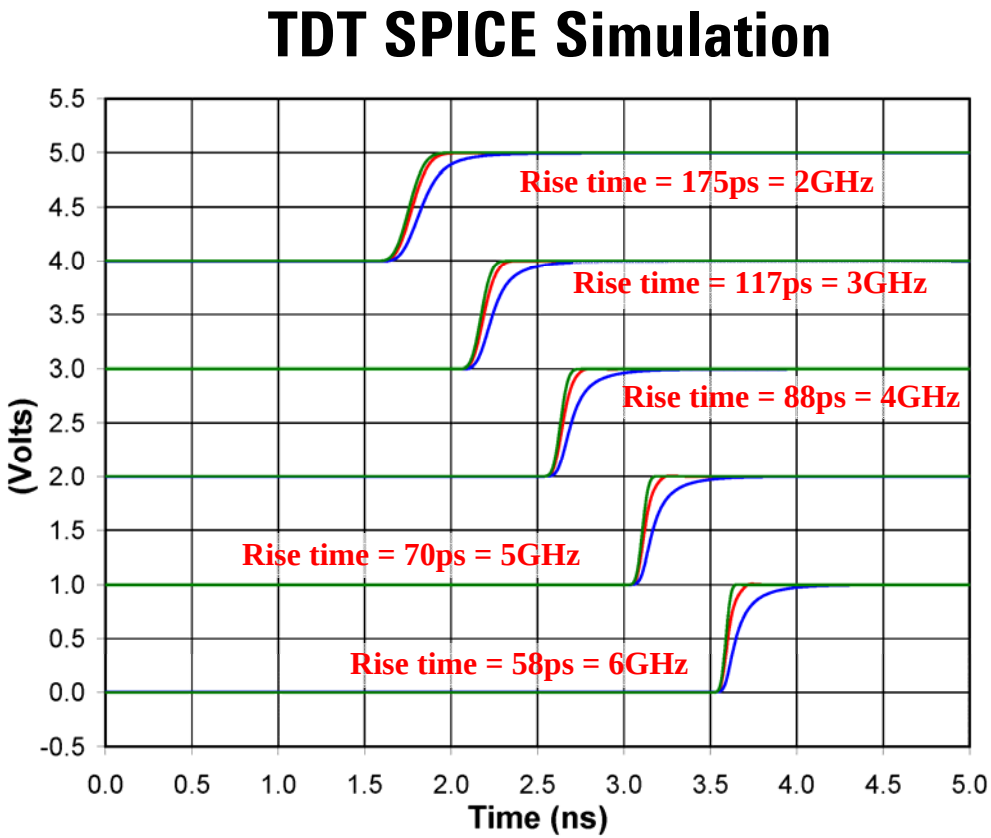


# Connector-Less Probing: Electrical Advantages

## Connector-Based vs. Connector-Less

(Mictor vs. SoftTouch)

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



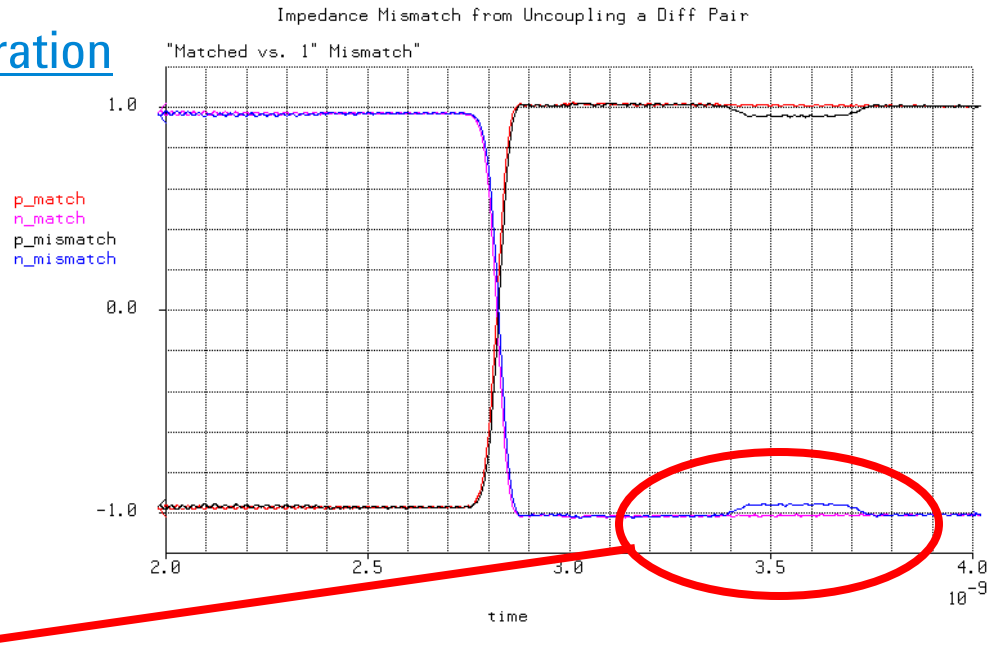
# Connector-Less Probing: Electrical Advantages

## Connector-Based vs. Connector-Less

(Mictor vs. SoftTouch)

### TDT SPICE Simulation

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

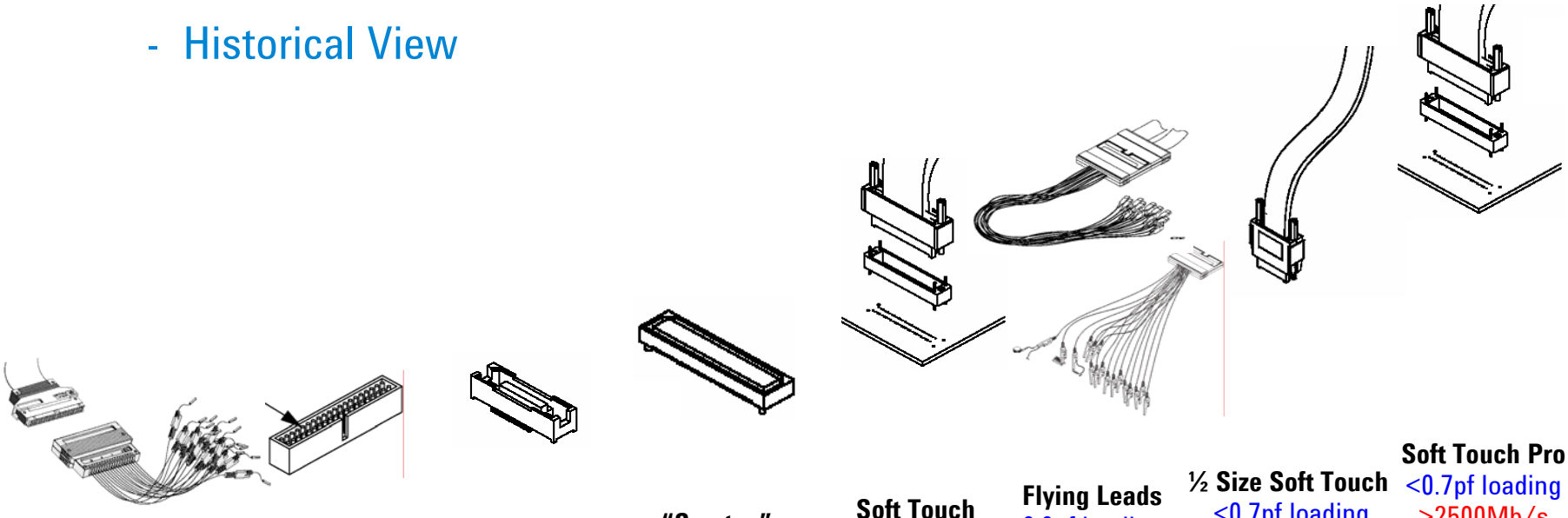



**Impedance Mismatch due to Uncoupling of Diff Pair**

# Connector-Less Probing: Electrical Advantages

## Connector-Based vs. Connector-Less

- Historical View



**1973** — First Logic Analyzer

**1985** — **"3M" 40-pin**
3pF loading
500Mb/s

**1996** — **"Mictor"**
3pf loading
600Mb/s
Industry Standard Footprint

**2000** — **"Samtec"**
1.5pf loading
1500Mb/s

**2003** — **Soft Touch**
<0.7pf loading
>2500Mb/s

**2003** — **Flying Leads**
0.9pf loading
1500Mb/s

**2004** — **½ Size Soft Touch**
<0.7pf loading
>2500Mb/s

**2004** — **Soft Touch Pro**
<0.7pf loading
>2500Mb/s
Industry Standard Footprint

# Connector-Less Probing: Mechanical Advantages

1) Ease of Assembly

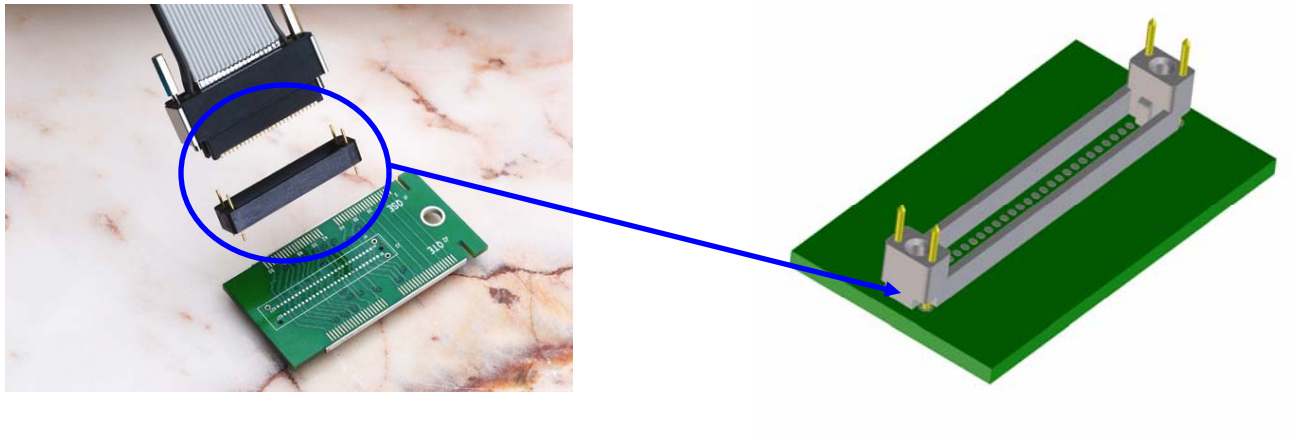
2) Mechanical Reliability

3) Post-Production Probing

# Connector-Less Probing: Mechanical Advantages

## 1) Ease of Assembly

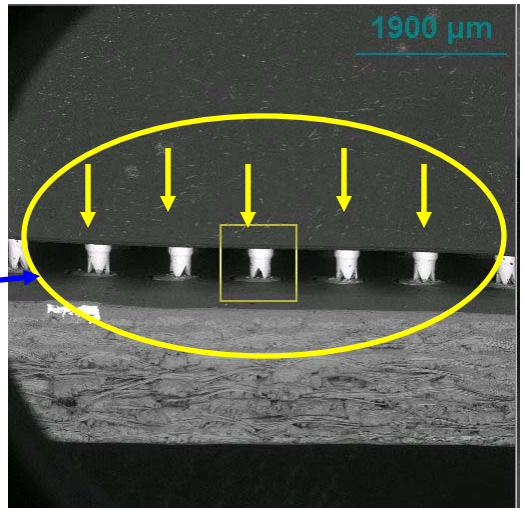
- **RM is hand-soldered**
- **No Machine Loading Needed**



# Connector-Less Probing: Mechanical Advantages

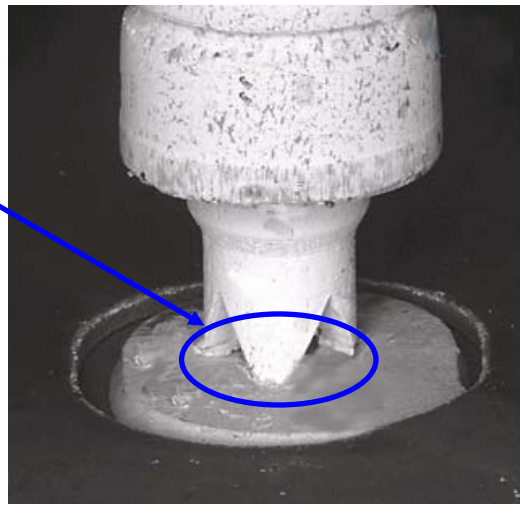
## 2) Mechanical Reliability

- **Spring-Pin Interconnect outperforms Standard Connectors**




**Planarity**

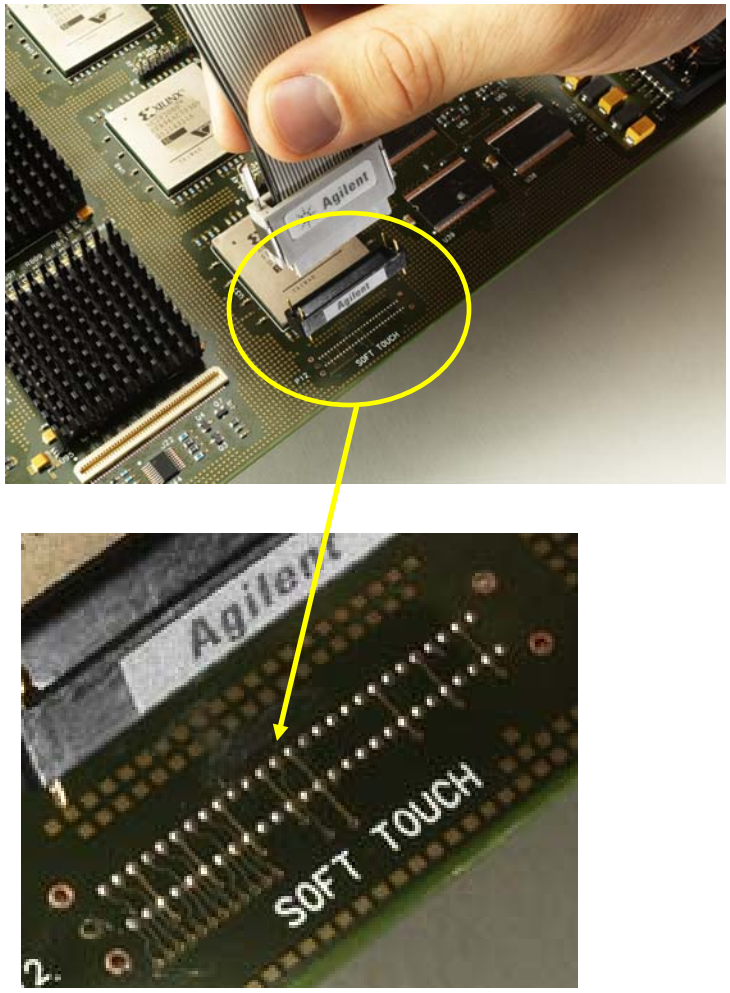
**Contamination**



# Connector-Less Probing: Mechanical Advantages

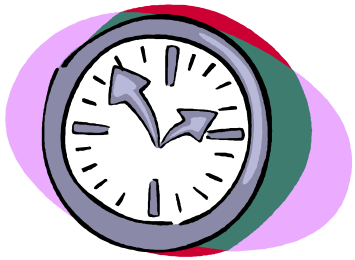
## 3) Post Production Probing

- **RM can be hand-loaded on production units**

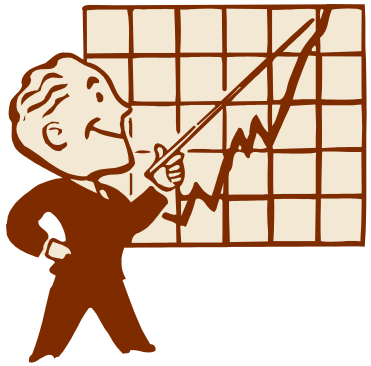


# So, what do these advantages mean to you???

## 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

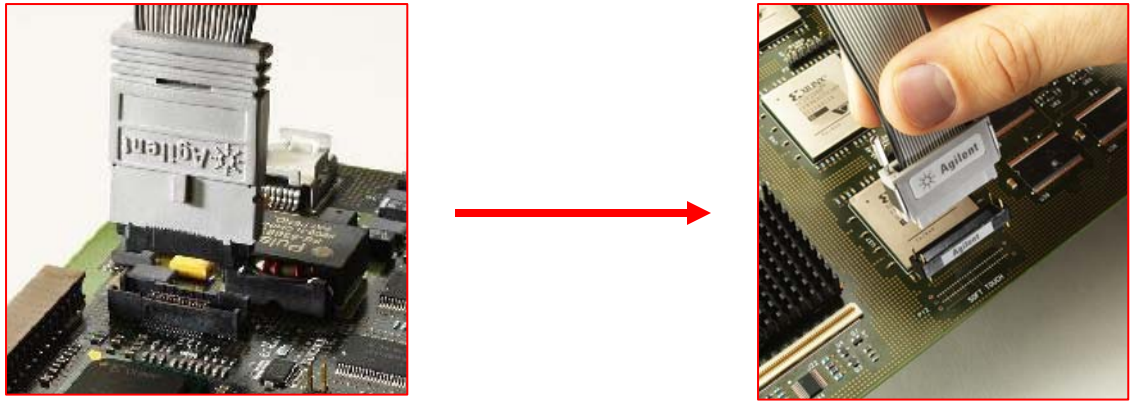


# Summary

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?