The Evaluation Examples of Connector modeling

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Agenda

- **Trend of AV Network Appliance**
- **Necessity of Connector Model Extraction**
- **Modeling Approach**
- **Model Validation**
- **Conclusions**
- **Comments for modeling & simulation**
- **Future Plan**

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Trend of AV Network Appliance

- Higher Speed(CLK:2x), Many functions(Network)

		1999	2000	2001	2002	2003	2004
Products	Mobile Communication	PDC i-Mode					
			W-CDMA 3G			3.5G	
	DigitalTV		HDTV BS Digital	ePF Service		Digitalized terrestrial broadcast	
AV SystemLSI	DesignRule	0.25μm	0.18μm		0.13μm		0.10μm
	Transistor	10M Tr	15M Tr		30M~50M Tr		
			HDTV SystemLSI		Second generation HDTV SystemLSI		
		SDTV SystemLSI	Second generation SDTV SystemLSI				
PWB Design	DesignRul	120 μm	100μm			80μm	
	Clock	50MHz	100MHz			150MHz	

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Key Points for Design

- ## 1. **S**peed
  ### *Time To Market*

- ## 2. **Q**uality
  ### *Design Quality*

- ## 3. **C**ost
  ### *Total Cost including Service*

- ## 4. **E**nvironment
  ### *Re- Use, Recycle , Unleaded* **S**older etc.

http://www.Panasonic.co.jp/

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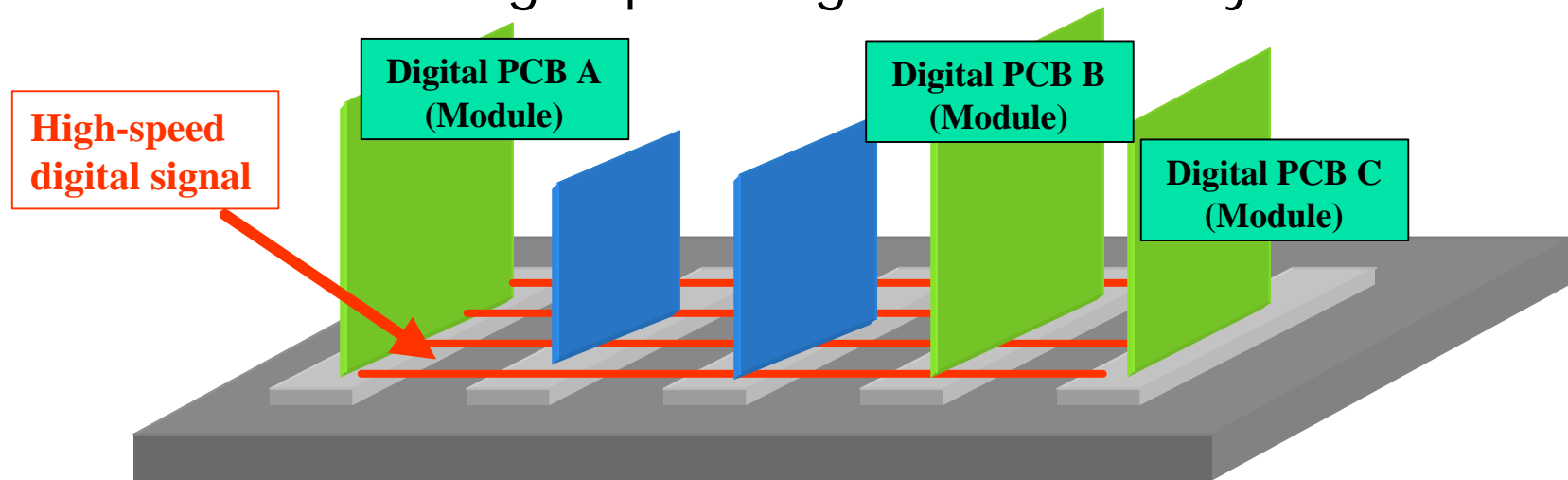
Necessity of Connector Model

- Needs to establish transmission between modules of high-speed digital signals
  - Before: High-speed signals are in only one PCB

High-speed digital signal

Digital PCB A (Module)

Digital PCB B (Module)

Digital PCB C (Module)

- More needs for simulation
  - Using DAC, bus-switch is not preferable
  - Can we use cheap connector?

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Necessity of Connector Model Extraction

- **Availability of a model**
  - Not all connector vendor provide models
  - A connector vendor doesn't always provide models for all types of connector
    - There are some models which aren't provided.
- **Provided models needs to be verified also**
  - Do the conditions of provided models suit our use or not?

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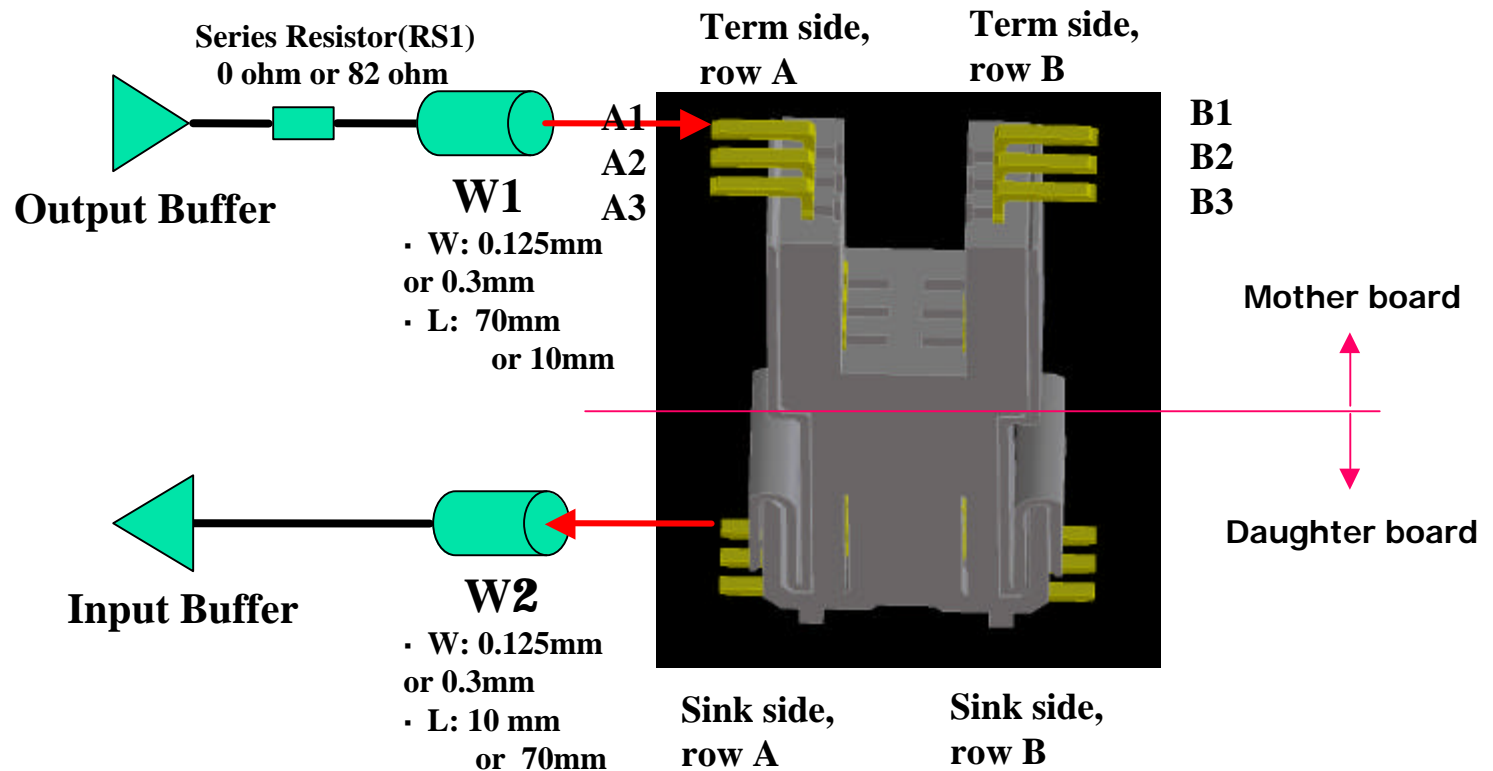# Modeling Approach

- We designed the evaluation board for model extraction
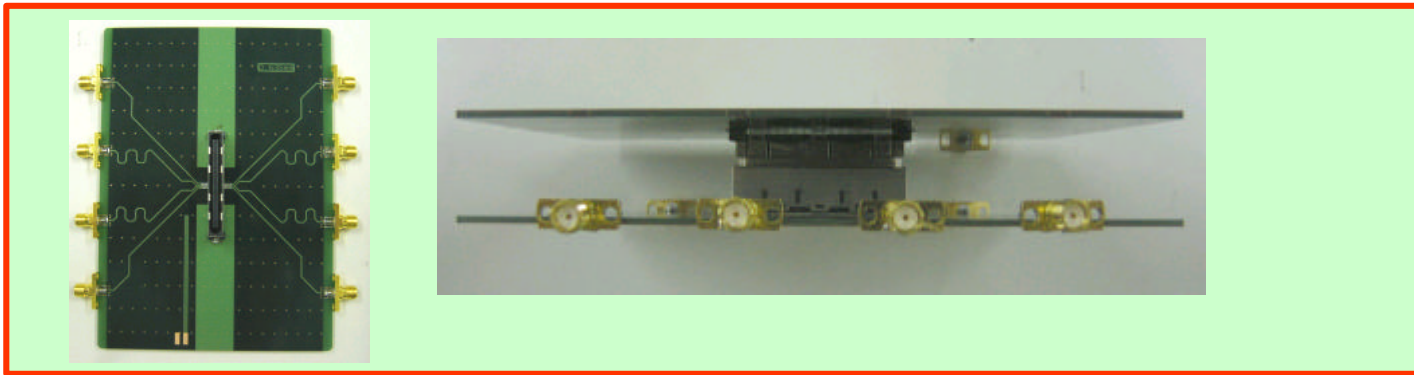
- Differential model extraction from differential TDR measurement
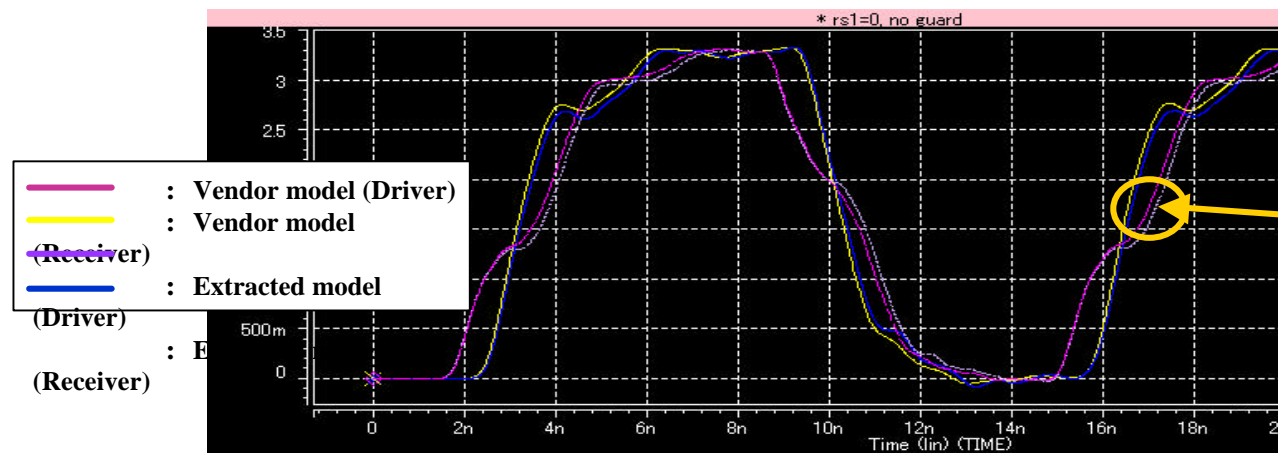 - To examine Cross-talk
  - To examine Pin assignment

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Model Validation by Simulation

- Comparison between vendor provided model and extracted model

Series Resistor(RS1)
0 ohm or 82 ohm

Output Buffer

W1
- W: 0.125mm or 0.3mm
- L: 70mm or 10mm

A1
A2
A3

Term side, row A

Term side, row B

B1
B2
B3

Mother board

Daughter board

Input Buffer

W2
- W: 0.125mm or 0.3mm
- L: 10 mm or 70mm

Sink side, row A

Sink side, row B

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Model Validation

- ## Simulation result 1 ... Influence of soldering

RS1 = 0Ω,

NC pins:75Ω termination

Legend (top chart):
: Vendor model (Driver)
: Vendor model (Receiver)
: Extracted model (Driver)
: Extracted model (Receiver)

Delay between vendor model and extracted model : 145ps
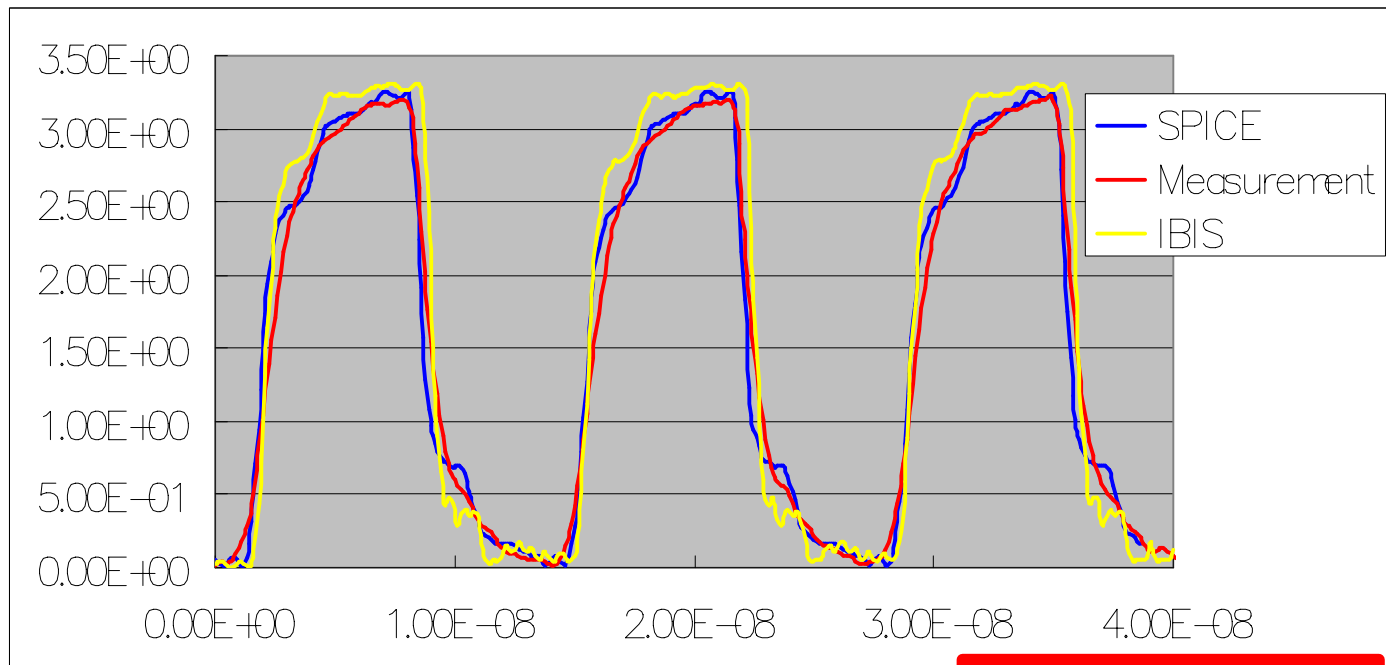
Almost same!
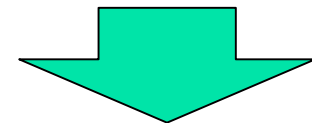
Legend (bottom chart):
:Vendor model +solder capacitance(0.1pF)
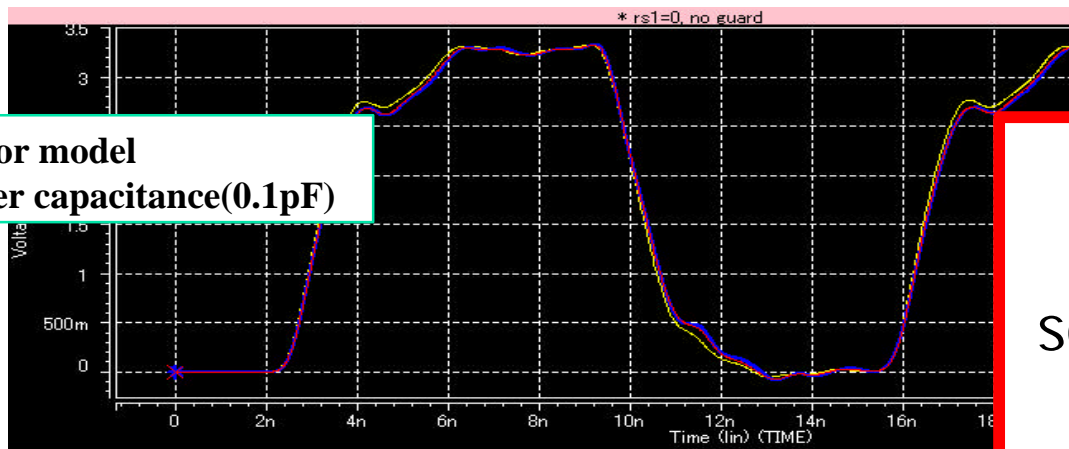
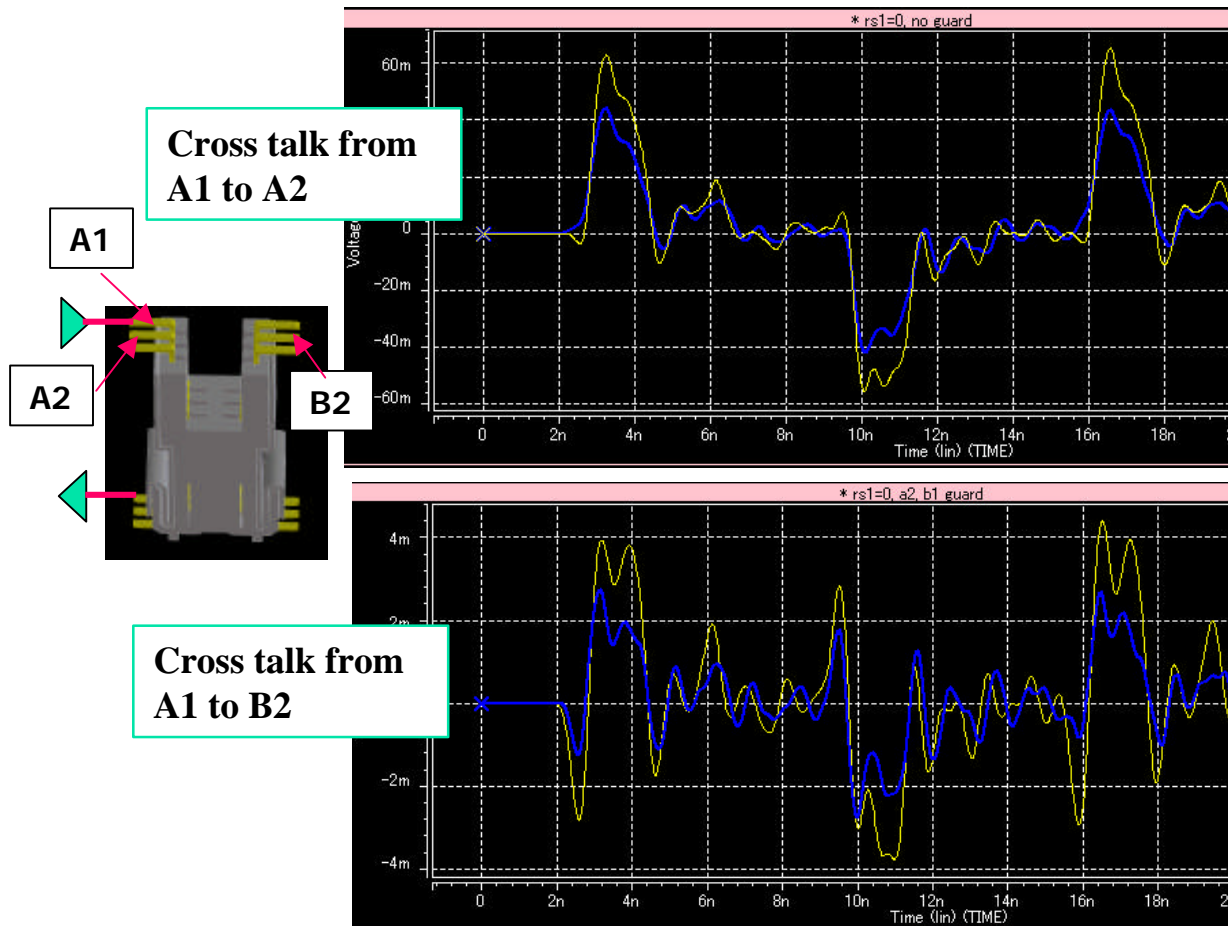Extracted model may includes soldering influences and useful

Model Validation

- Comparison between measurement and simulation ... receiver waveform

Good result!

Model Validation

- **Simulation result 2 …** Cross talk 1

Cross talk from
A1 to A2

A1

A2

B2

Cross talk from
A1 to B2

RS1 = 0O,

NC pins:75Otermination
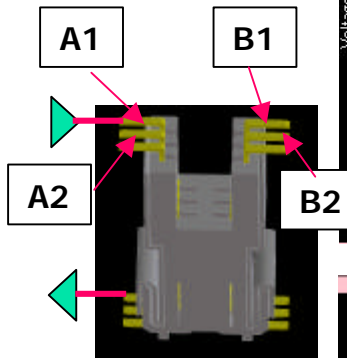

	: **Vendor model**
	: **Extracted**

model

Good result as a
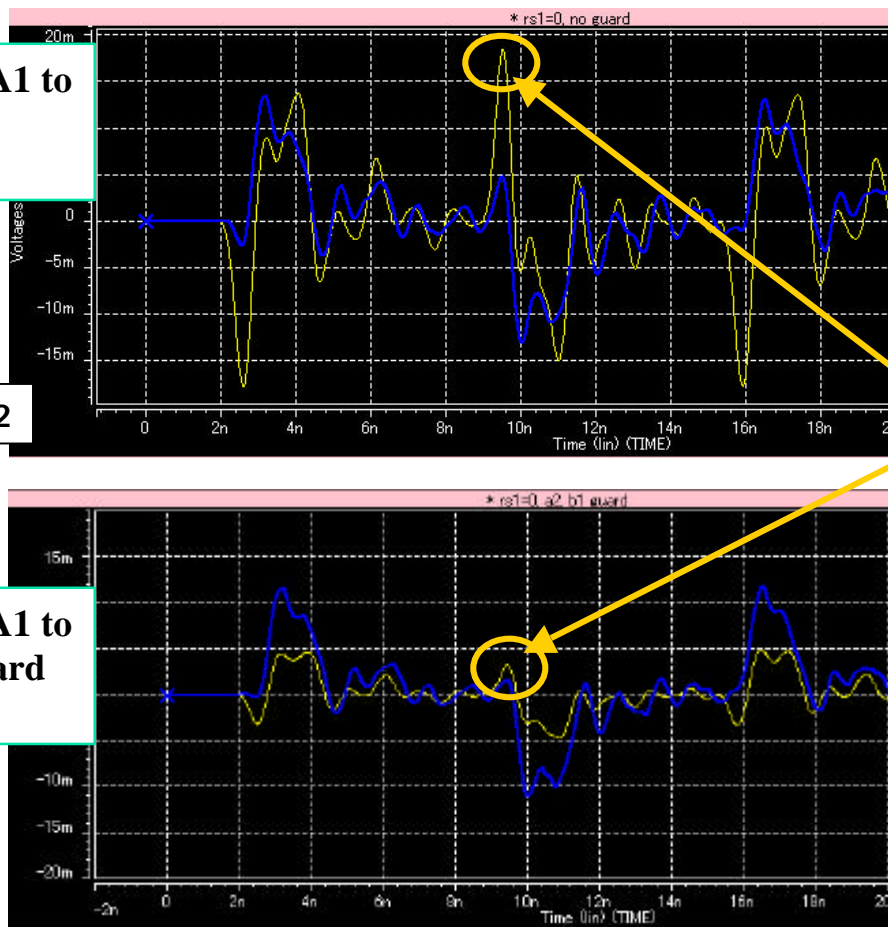1st step

Model Validation

- ## Simulation result 3 ... Cross talk w/wo guard

Cross talk from A1 to B2 without GND guard A2, B1

A1   B1

A2   B2

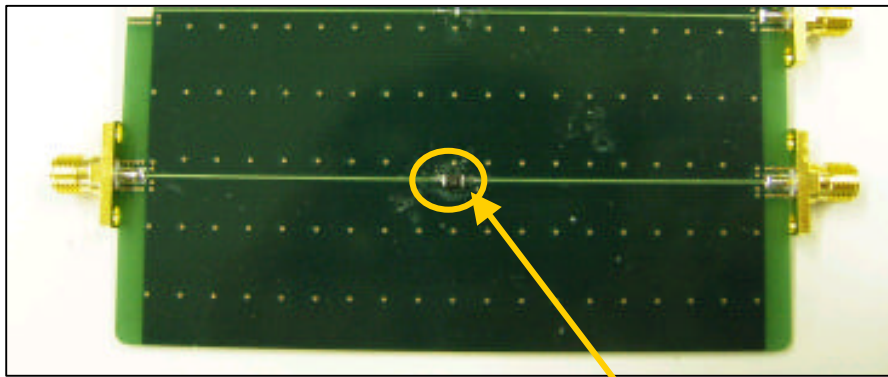**Cross talk from A1 to B2 with GND guard A2, B1**

RS1 = 0O,

A2, B1: 75O termination or GND

NC pins:75O termination

Vendor Model shows much differences between 'with GND' and 'without GND'

Need to compare with measurement result

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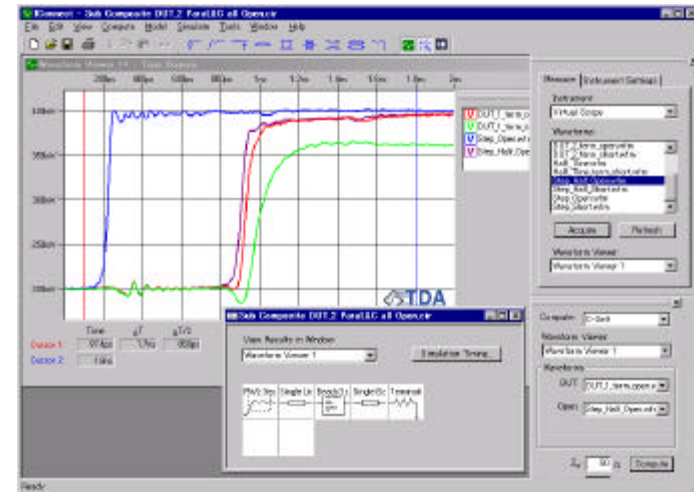
[FYI] Passive Components Model Extraction

- Currently trying....

Target components(e.g. beads)

- Issues

  - The equivalent circuit of a target needs to be known to some extent

  - TDR measurement accuracy, parameter extraction method will be the key

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Conclusions

- Extracted model showed good result compared with vendor model & measurement
    - **Transmission characteristics, cross talk were the good result though we didn't do enough parameter fitting with measurement result**
- If connector models aren't provided from vendor, we can evaluate SI, cross talk by using TDR extracted model
    - We can evaluate more types of connector

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Comments for modeling & Simulation

- **All simulations were done by SPICE**
  - Extracted connector model is also SPICE
    - Model translation is necessary for SI simulators
      - <u>**Connector description in IBIS is preferable**</u>
    - SPICE is not easy to use

- **IBIS model is faster than SPICE model**
  - SPICE:10minutes? IBIS:1-2minutes
    - Simulation speed is important for floor planning
      - Many kind of what-if case simulations are necessary
  - Accuracy is also important
    - Survey   accuracy guideline

Future Plan

- **Board to board simulation with connector**
  - With Power/GND plane (real PCB data)
    - We expect IBIS treats behavior of Power/GND

- **Total system simulation**
  - Package, via, passive components

LSI Chip

Passive Components

Connector

Package

Power/GND plane

Via

Transmission Line

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