IBIS Correlation Method Based on Product Board Measurement

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HUAWEI TECHNOLOGIES Co., Ltd.

Agenda

- IBIS Correlation Procedure
- Shortcomings of the Current Method
- Measurement Correlation in Huawei
- Report

IBIS Correlation Procedure

In the *I/O Buffer Accuracy Handbook,* the IBIS correlation is defined as a two-step procedure :

- the semiconductor vendors correlate lab data against SPICE-based golden waveforms that are embedded in the IBIS datasheet in the form of voltage-time tables.
- the user correlates behavioral simulation results against the same golden waveforms using his or her simulator of choice.

Due to the model developers owning more source and equipment, the method above is more suitable for the model developers.

IBIS Correlation – IBIS model developer

According to the procedure above, the IC vendors divide the IBIS correlation into Measurement correlation and SPICE correlation:

- Measurement Correlation

  Using the Measurement data, the IC vendors can correlate the SPICE-based golden waveforms or IBIS models.

  Requirements: equipment, actual silicon, evaluation board.

- SPICE Correlation

  Using the SPICE models, the IC vendors usually are able to validate the IBIS model in a variety of load conditions. However, In the report, the correlation is carried out under some typical load conditions and the topology of the circuit is simple.

  Requirements: accurate SPICE model or golden waveforms, SI Simulation Software.

Now, the IBIS correlation method is not widely used. A few IC vendors provide the IBIS correlation report. But most model developers have not been making IBIS correlation. So the IBIS users have to do an IBIS correlation when they simulate the circuit.

Shortcomings of the Current Method

For IBIS model users:

- Feasibility
  - **Owing to the IPR, it is difficult to obtain the accurate SPICE models for the IBIS users. In addition, there are not enough golden waveforms in the IBIS model. So SPICE correlation is not a feasible way.**
- High Expense
  - **To do measurement correlation, some special and expensive equipment in the current method are needed.**
- Evaluation Board
  - **It is difficult for IBIS users to get chip evaluation board and IBIS users couldn’t carry out measurement correlation work on evaluation board.**
- Application Environment
  - **The users apply the chip on the product board with complex circuit topology. So the user wants to know the differences between the simulation and the signal of product board. Some correlation in idea load may be not good enough.**

Conclusion:

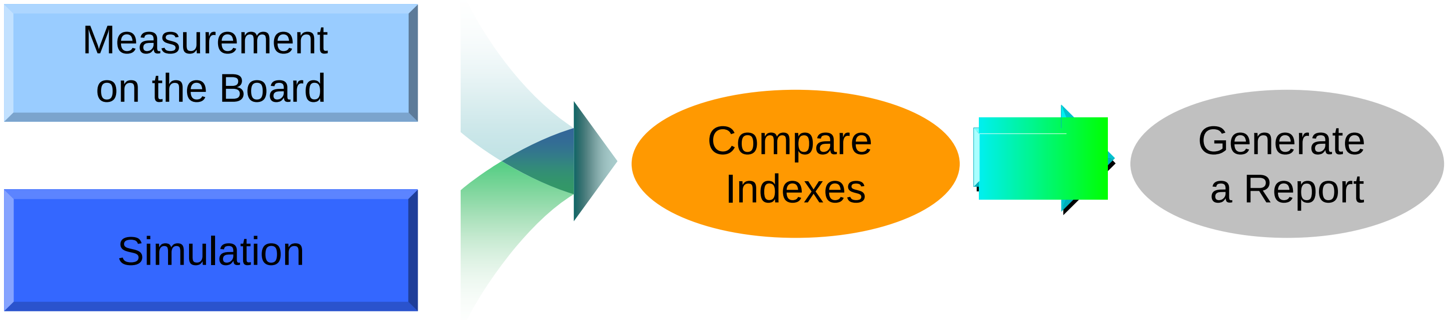
The IBIS users need an easy and practical method for IBIS correlation.

Measurement Correlation in Huawei

On the basis of the *I/O Buffer Accuracy Handbook,* the engineers in Huawei develop a method for the IBIS users.

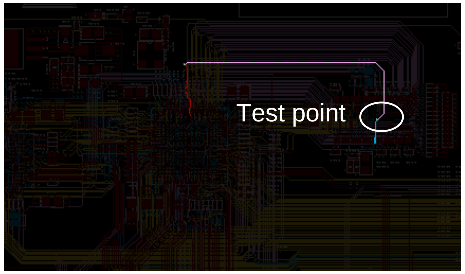
The procedure of the method:

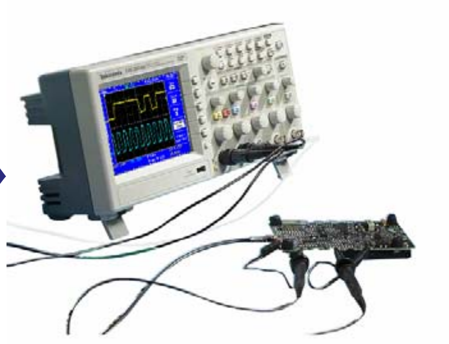
- Measure with general equipment
  - Do a measurement on the products board not on the evaluation board or die.
- Simulate
  - Simulate the same signal in the SI software..
- Compare
  - According to our index, compare the test results with simulation results.
- Generate a report

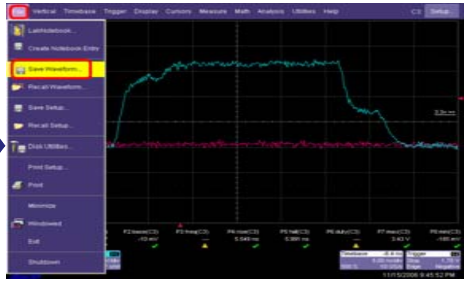


Measurement Correlation - Measurement

- Choose link and test-point
  - The link is less sensitive to crosstalk and ground bounce.
  - The test-point near the receiver pin.
- Probe signal
  - Use suitable Instrument.
  - Test waveforms in the normal state of the buffer.
- Waveform
  - Snatch valid waveform and save it as the formats of .txt and .jpg.







Measurement Correlation - FTS (fast, typical, slow) simulation

- PCB stackup

  Set the impedance same as the product board.

- Link topology

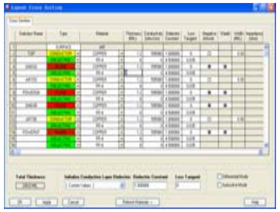
  Extract the topology from the board.

- Probe location

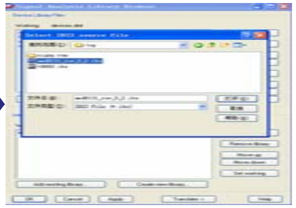
  Place it at the same position as the test point.

- Simulate

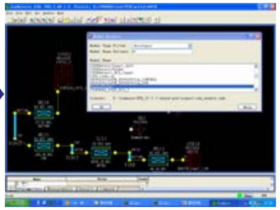
  Simulate the circuit at the FTS (fast, typical, slow) corners with the SI software and save the simulation results as the formats of .txt and .jpg.



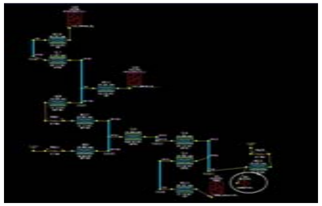
Set the stack-up



Extract topology



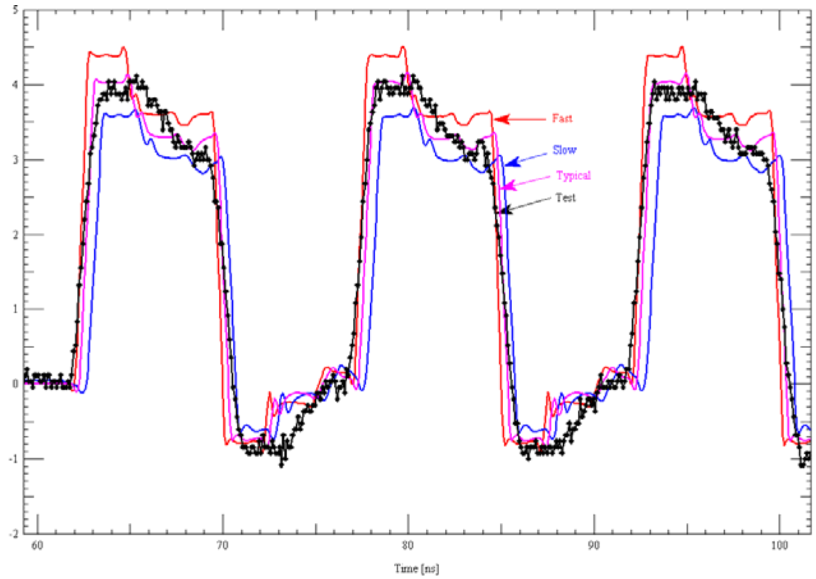
Probe



FTS simulation

Measurement Correlation - Curve comparison

- Import the measurement result and simulation result into the display picture software.
- Offset the test curve at the X axis, and make the test curve and the typical curve of the simulation overlap at the Vt voltage.
- Observe the differences between the test curve and simulate curves.
- Measure the indexes and fill in the following table.



Measurement Correlation – Index comparison

	Correlation Index	Simulate value/Fast	Simulate value/Typ	Simulate value/Slow	Test value	Comparative result	Correlation Index	Remark
Waveform	1.1 waveform similarity	NA	NA	NA	NA	NA		
	1.2 Eye Diagram	NA	NA	NA	NA	NA		
Required	2.1 High DC Level (V)	3.6	3.3	3	3.18	Between Fast corner and Slow corner, closed to Typical corner	-0.2	
	2.2 Low DC Level (V)	-0.02	0.01	0.06	0	Between Fast corner and Slow corner, closed to Typical corner	NA	
	2.3 Overshoot (V)	4.51	4.14	3.67	4.12	Between Fast corner and Slow corner, closed to Typical corner	-0.228882834	
	2.4 Downshoot (V)	-0.94	-0.87	-0.73	-0.11	Beyond Fast corner	NA	
	2.5 High Level valid pulse(ns)	7.34	7.23	7.11	7.33	Between Fast corner and Slow corner, closed to Typical corner	-0.032348805	
	2.6 Low Level valid pulse(ns)	7.34	7.32	7.36	6.82	Beyond Slow corner	0.005434783	
	2.7 Rise time(ns)	0.18	0.23	0.28	0.38	Beyond Slow corner	NA	
	2.8 Fall time(ns)	0.2	0.23	0.3	0.45	Beyond Slow corner	NA	
	2.9 Edge Monotony	Yes	Yes	Yes	Yes	NA		
Optional	2.10 Overshoot Low	NA	NA	NA	NA	NA		
	2.11 Downshoot High	NA	NA	NA	NA	NA		
	2.12 Eye Width	NA	NA	NA	NA	NA		
	2.13 Eye Height	NA	NA	NA	NA	NA		
Conclusion	Pass the Measure Correlation							
	Remark：							

Measurement Correlation – Index criteria

The comparison puts the emphases on the consistency of the curves.

- Measure the indexes
  - According to our requirements, test some concerned indexes.
- Estimate these indexes
  - whether the test indexes are enveloped by the simulation indexes of the Fast and Slow corners.
- Observe which index of the FTS simulation is closed to that of the test curve.
- The remark column = ((Test – Simulate) /Test) × 100%).
  - The simulate value is the closest to the test value. The entries marked NA, if the voltage is so low that the meaningful error is impractical

If the test indexes are enveloped by the Fast and Slow indexes or the test indexes which are not enveloped by the Fast and Slow indexes are reasonable, the users consider that the IBIS model passes the Measurement Correlation.

Measurement Correlation – Highlights & Lowlights

Highlights:

- Easy and practical
  - It is easy for the users to manipulate the equipment.
- Simple maintenance and small charge
- Objective result
  - The test is on the products board. So the condition is closed to fact and the result of the correlation is more objective.

Lowlights:

In the correlation, there are some conditions:

- Assume the receiver model is accurate.
- Neglect the influence of the environment noise and the parasitic parameters (probe, test point, .etc)

Measurement Correlation – Generate a Report

Using the information above to generate a report, which should include the information below :

1. The engineer information
2. The buffer information
3. The product board information and the signal of the buffer
4. Test environment
5. The topology of the circuit
6. The simulation file and the output of the simulation and test
7. Compare the waveforms

   7.1 FTS waveforms and test waveforms

   7.2 Parameter comparison

Report

AMD8131_REV_0_2_PCIX_LO Report

1 Engineer Information

Name	***
Department	***

2 Buffer Information

	Buffer Name	Model Name	PDM Code	Part Number	IBIS file source
Transmitter	AMD8131_REV_0_2_PCIX_LO	amd8131_bga829	38130032	AMD 8131BLCWB2	标准库
Receiver	T9000_bdzpcix_ls33rc_pci	t9000_bga1152	43100030	T9000	标准库

3 Board and Signal Information

Board Name	***
Signal Name	pci_a_ad1
Data Rate	266Mbps

4 Measure Environment

Temperature（℃）	Normal		
Oscilloscope	TDS7404B	Band width （GHz）	4
Probe	P7225	Band width （GHz）	2.5

5 Circuit Topology

Actual Measurement Picture (position of the test point)

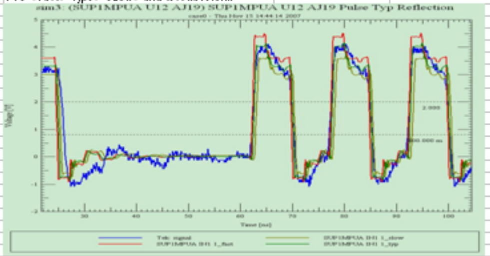
Topology of circuit (po

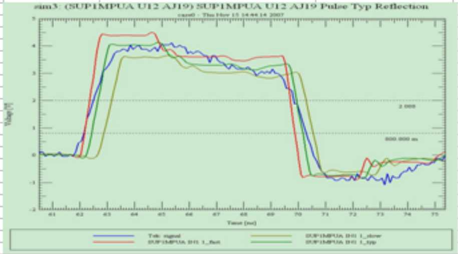
6 Required Files

Simulated File Name：TOP	Transmitter and Receiver IBIS file (Model name.ibs), Transmitter and Receiver DML file (Model name.dml)
	Topology file(Signal name.top)，System DML file （devices.dml,interconn.iml）
Test waveform File Name:TESTWAVE	Test waveform File （Signal name.bmp or Signal.jpg),Test waveform data File （Signal name.txt or Signal.dat)
Simulate waveform File Name:SIMULATIONWAVE	Simulate waveform （Signal.sim） -Include four curves

7 Waveform comparison

7.1 FTS（Fast，Type，SLow）and test waveform





7.2 Index Correlation

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	1.2 Eye Diagram	NA	NA	NA	NA	NA		
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AMD8131_REV_0_2_PCIX_LO

IBIS Correlation Report

Proposal on IBIS Quality Specification Rev1.1ac

The Measurement Correlation is more important to IBIS users than others. So it is necessary to demonstrate Measurement Correlation on the IBIS Quality Specification.

Proposal:

Add “Measurement Correlation” into IBIS Quality Specification Rev1.1ac, and so the Measurement Correlation parallel as SPICE Correlation.

The section 7 is a bit confusing. I propose to reorder the index.

The IBIS Quality Specification is not only for model developers, but also for model users. The procedure of IBIS correlation should be easy and practical for model users.

Acknowledge

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