A PRACTICAL DOE APPLICATION IN STATISTICAL SI ANALYSIS USING IBIS & HOW CAN WE MAKE IBIS WORK BEYOND BEST CASE/WORST CASE?

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Authors:
AGENDA

› IBIS & Statistical analysis
› DOE as a statistical methodology
› Practical DDR3/DDR4 Topology problem solved by DOE
› How can we extend IBIS to support confidence interval analysis.
› Suggestion to enhance IBIS typ, min, max corners with distribution data.
› Conclusion

DOE & IBIS | Ericsson Presentation | Asian IBIS Summits | October 2015 | Page 2 (14)
IBIS & STATISTICAL ANALYSIS

› IBIS based SI analysis uses:
  – Behavioral buffer models. typ, min, max (BC/WC)
  – Trace modeling of topology BC/WC
  – Via modeling BC/WC

› Best Case / Worst case analysis assumes:
  – 100% confidence interval. Every produced individual works.

› Statistical SI analysis predicts:
  – Defects at a given confidence interval.
  – Help manage overdesign and possible BC/WC failures.
DOE AS A STATISTICAL METHODOLOGY

› DOE Design Of Experiments will fit a model to our solutions space (often used is a RSM Response Surface Model)
› Uses much fewer simulation than sweep analysis or Monte Carlo analysis.
› Catches cross term interaction missed by OFAT analysis.
  – (OFAT, One Factor At a Time)

› RSM used to predict the fitted part of the solutions space and to give Confidence Intervals for the predicted respons.
Problem of ringing in a high speed DDR3/DDR4 address/command/control bus in memory down solutions with thick PCB’s >1mm.

Find an optimal topology that solves the problem with a given confidence e.g. 95%
PRACTICAL DDR TOPOLOGY PROBLEM SOLVED BY DOE

› DDR3/DDR4 address/command/control bus topology
  – Flyby? Daisy-chain. → Reflection
  – Thick PCB’s >1mm. → Ringback
# Practical DDR Topology Problem Solved by DOE

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Factor</th>
<th>Factor Type</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Analysis Type</th>
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<tr>
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<td>2=typC</td>
<td>3=lowC</td>
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Prediction Profiler

- Confidence interval -------> Quality
- Slope -------> Influence /Importance
- Vertical red line -------> “What if ” analysis & Interactions
- Desirability function -------> Optimization
PRACTICAL DDR TOPOLOGY PROBLEM SOLVED BY DOE

DOE Optimization

[Diagram showing various plots and waveforms related to DOE optimization.]
PRACTICAL DDR TOPOLOGY PROBLEM SOLVED BY DOE

› DPM (Defects per Million)
  - Equation Simulator to evaluate the response equation at millions of conditions.

- Realistic predicted yield plots obtained in seconds.
IBIS currently and traditionally uses a typ, min, max parameter definition.

This is based on a Best/Worst case scenario analysis. E.g. 100% confidence.

Best/Worst case analysis has served us well during the years and still does in some cases, however more and more cases will not reach design closure using Best/Worst case analysis.

When it does not reach design closure how will we know how many of our produced units will fail ????

IBIS
If we add an option to IBIS to support distribution data for parameters as an average/mean and a variation/sigma.

If we feel we can not assume a standard distribution we could even add support for other distributions.

These parameters could be used in DOE analysis scenarios and could help us predict confidence intervals for our products as well as DPM (Defect Per million) predictions.
CONCLUSIONS.

› Our design work is moving beyond Best case, Worst case analysis.
› We need to start working on an infrastructure both in modeling and tool support for statistical analysis.
› Many of us EE’s need to go back to our statistics books and review statistical analysis.
› We need to secure that we can get the correct information from IC and PCB vendors on parameter distributions.
› SI/PI statistical analysis is the next step to secure our product quality.