Subckt Package Model in IBIS

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Agenda

• Standard IBIS Package Model Overview

• Requirements on IBIS Package Model in High Speed Circuit Analysis

• Proposed IBIS Subckt Package Model

• Summary
Standard IBIS Package Model Overview

- Existing Simplified IBIS Package Model
  - Single RLC value

- Customized IBIS Package Model
  - Segmented/Forked RLC value

- Coupled IBIS Package Model
  - RLC Matrix value

- Pin Mapping in Pin Numbers and Model Data Section
  - 1:1 mapping of die pins to package pins
  - Simple RLC for each signal, power and ground pin
Agenda

• Standard IBIS Package Model Overview

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• Summary
Extracted Package Model by Field Solvers & Measurements

• Current Standard IBIS Package Model Format
  – Very simple RLC value with 1:1 mapping of BGA pins to Die pins
  – It makes little sense for each pwr/gnd pins

• Subckt Model for Coupling Signal, Power and Ground Nets from Field Solvers
  – Complex Spice subckt with high accuracy & efficiency by pwr/gnd pins group process

• Touchstone Format S Parameter Model from Field Solvers or Measurement
  – S/Y/Z parameter model and related Subckt model can be obtained conveniently

• Today’s power & SSN analysis with lower voltage and higher current require high accurate power, ground (including decaps) and signal nets coupling circuit model for higher simulation accuracy and efficiency
  – Subckt or S parameter models are required
  – Pin-Port Mappings are required by full system high speed circuit analysis

Notes: Current IBIS Package Model is NOT ENOUGH for high speed circuit analysis, especially for Power analysis & SSN simulation
How to Use the Extracted Subckt Package Model

• Create the Whole Circuit Netlist by Editing the Connection between the Extracted Spice Package Model and S Parameter Model in Text File Format
  – Good

• Create the Connection between the Package Model and other Models in GUI with additional Pin-Node Mapping file Manually
  – Better

• Create the Connection between Package Model and other Model automatically through Enhanced IBIS Package Model
  – Best and it’s a Standard

Notes: Consume complicated/coupled signal & power net subckt in IBIS models
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Existing IBIS Package Model in V5.0

- [Define Package Model]
  ----------------------
  |     |-- [Manufacturer]
  |     |-- [OEM]
  |     |-- [Description]
  |     |-- [Number Of Sections]
  |     |-- [Number Of Pins]
  |     |-- [Pin Numbers] Len, L, R, C, Fork, Endfork
  |     |-- [Model Data]
  |     |   ------------
  |     |     |-- [Resistance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  |     |     |-- [Bandwidth]
  |     |     |-- [Row]
  |     |     |-- [Inductance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  |     |     |-- [Bandwidth]
  |     |     |-- [Row]
  |     |     |-- [Capacitance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  |     |     |-- [Bandwidth]
  |     |     |-- [Row]
  |     |-- [End Model Data]
  |     |-- [End Package Model]

- [Define Package Model]
  ----------------------
  |     |-- [Manufacturer]
  |     |-- [OEM]
  |     |-- [Description]
  |     |-- [Number Of Sections]
  |     |-- [Number Of Pins]
  |     |-- [Pin Numbers] Len, L, R, C, Fork, Endfork
  |     |-- [Model Data]
  |     |   ------------
  |     |     |-- [Resistance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  |     |     |-- [Bandwidth]
  |     |     |-- [Row]
  |     |     |-- [Inductance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  |     |     |-- [Bandwidth]
  |     |     |-- [Row]
  |     |     |-- [Capacitance Matrix] Banded_matrix, Sparse_matrix, Full_matrix
  |     |     |-- [Bandwidth]
  |     |     |-- [Row]
  |     |-- [End Model Data]
  |     |-- [End Package Model]
What’s New in the Enhanced IBIS Package Model

- [Define Package Model]
- [Manufacturer]
- [OEM]
- [Description]
- [Number Of Sections]
- [Number Of Pins]
- [Pin Numbers]
- [Model Data]
- [End Model Data]
- [End Package Model]

It also supports multiple Subckt models in one package with its pin node mapping.
Keywords for Proposed IBIS Package Model

- **Keywords:**
- | [Subckt Package Model]

|==================================================================================================|
| Keyword: [Subckt Model Data] | Required: Yes | Description: Indicates the beginning of the formatted subckt package model data, that can include the spice subckt or s parameter model keywords. |
|-------------------------------------------------------------------------------|

|==================================================================================================|
| [Pin-Node Mapping] | [End Pin-Node Mapping] | [Subckt Model Data] | [End Subckt Model Data] |

|==================================================================================================|
| Keyword: [End Subckt Package Model] | Required: Yes | Description: Indicates the end of the formatted model data. | Other Notes: In between the [Subckt Package Model] and [End Subckt Package Model] keywords is the pin node mapping, data itself of subckt package model. |
|-------------------------------------------------------------------------------|

|==================================================================================================|
| [End Subckt Package Model] |

Notes: The goal is to specify a complicated spice-like subckt package model instead of standard simple RLC package model to be used by the keyword Subckt Package Model.
Keywords for Proposed IBIS Package Model

- **Keywords:**

  | Keyword: [Pin-Node Mapping] |
  | Required: Yes |
  | Description: Indicates the beginning of the formatted Pin Node mapping data for subckt package model data. |

| [Pin-Node Mapping] |

- **Keywords:**

  | Keyword: [End Pin-Node Mapping] |
  | Required: Yes |
  | Description: Indicates the end of the formatted pin port mapping data. |
  | Other Notes: In between the [Pin-Node Mapping] and [End Pin-Node Mapping] keywords is the pin port mapping data itself. The data is a set of subckt node name like N001, pin name like VDD01 and net name like Net1 as below |
  | N001 VDD01 Net1 |
  | N002 VDD02 Net1 |
  | N003 VDD03 Net2 |
  | N004 VSS01 Net3 |
  | The net name like Net1 is ”OPTIONAL” |

| [End Pin-Node Mapping] |
Keywords for Proposed IBIS Package Model

- Keywords:
  - [Subckt Model Data]
  - [End Subckt Model Data]

[Subckt Model Data]

<table>
<thead>
<tr>
<th>Keyword: [Subckt Model Data]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required: Yes</td>
</tr>
<tr>
<td>Description: Indicates the beginning of the formatted subckt package model data, that can include the subckt or s parameter model keywords.</td>
</tr>
</tbody>
</table>

[End Subckt Model Data]

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<tr>
<td>Required: Yes</td>
</tr>
<tr>
<td>Description: Indicates the end of the formatted subckt model data.</td>
</tr>
<tr>
<td>Other Notes: In between the [Subckt Model Data] and [End Subckt Model Data] keywords is the data itself for subckt package model.</td>
</tr>
<tr>
<td>The data is a set of spice subckt or S parameter model as below</td>
</tr>
<tr>
<td>Spice: “.subckt PowerModel N001 N002 N007 N008 ... .ends PowerModel”</td>
</tr>
<tr>
<td>Or S parameter: “.MODEL name sp [DATA=(npts ...)] [DATAFILE=filename]</td>
</tr>
</tbody>
</table>

[End Subckt Model Data]
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Summary

• Requirements on IBIS Package Model
  – Accurate Power/SSN analysis with a complex package model

• Proposed Subckt Type in IBIS Package Model
  – Spice circuit or S parameter data

• Applications for IBIS Subckt Package Model
  – IC-Package-Board co-design flow and Design Link
Action items

• Add the proposed subckt package model keywords into standard IBIS package part

• IBIS parser parses the subckt package keywords
  – Similar use model to existing lumped package model

• EDA tools consume the subckt package model to create circuit netlist