

IBIS Interconnect Modeling Specification (ICM) Status


By
Michael Mirmak
Intel Corporation

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ICM Refresher

- **ICM = IBIS Interconnect Modeling Specification**
- **Purpose: to establish a human-readable standard format for exchanging interconnect modeling data**
 - “Interconnect” can be connector, cable, PCB traces or even an IC package
- **ICM uses a two-part format:**
 - **Description of model in terms of one or more sections with terminals mapped to named pin/node lists**
 - *Nodal arrangement with explicit interconnections*
 - *Tree arrangement with implicit interconnections*
 - **Electrical data describing each section**
 - *RLGC matrix data*
 - *S-parameter data (external Touchstone® file)*



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A Partial Example



Tree Description

```
[Begin ICM Model] MyModelExample7
ICM_model_type SIM_quiescent
[Tree Path Description]
Model_pinmap = MyModelPinMapA
Section Mult=1 SectionA
Section Mult=1 SectionB
Section Mult=1 SectionC
Section Mult=1 SectionD
Fork
  Section Mult=1 SectionF
Model_pinmap MyModelPinMapB
EndFork
Section Mult=1 SectionE
Model_pinmap MyModelPinMapC
-
-
[End ICM Model]
```

Pins

Nodal Description

```
[Begin ICM Model] MyModelExample7
ICM_model_type MLM
[Nodal Path Description]
Model_nodemap Port1
N_section (A1 A2 A3 A4 A5 11 12 13 14 15) Len=1.0 A
N_section (11 12 13 14 15 21 22 23 24 25) Len=1.0 B
N_section (21 22 23 24 25 31 32 33 34 35) Len=1.0 C
N_section (31 32 33 34 35 s1 s2 s3 s4 s5) Len=1.0 D
N_section (s1 s2 s3 s4 s5 F1 F2 F3 F4 F5) Len=1.0 F
Model_nodemap Port3
N_section (s1 s2 s3 s4 s5 E1 E2 E3 E4 E5) Len=1.0 E
Model_nodemap Port2
[End ICM Model]
```

**A more formal example is available
at the end of this presentation...**



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ICM History

- **Initial concept developed 1995 - 1997**
 - IBIS Connector/Futures Subcommittee
- **Sporadic revisions 1999 – 2002**
- **Internal Draft 1.0 released Sept. 19, 2002**
- **Committee Internal Drafts 1.0a – 1.0g**
- **Final Draft 1.0 released publicly May 16, 2003**
 - See IBIS web site under “Connector Info”



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What Changed in Final Draft 1.0

- **Over 63 issues formally logged since Sept. 2002**
 - More than two dozen additional small issues resolved
- **Most changes were editorial**
 - Spelling, punctuation and grammar
 - Standardization to improve software parsing
 - Name changes for consistency with IBIS 4.0
- **Some technical limitations established**
 - RLGC and S-parameter sections not permitted within the same model (allowed in the same file)
 - S-parameter data only to be used with [Nodal Path Description] keyword
 - Implicit use of single-ended ports for S-parameter data

More details under “Long-Term Issues”



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Short-Term Future

- **ICM now in IBIS Open Forum Review**
 - Officially introduced at May 30 meeting
 - Minimum of three Open Forum meetings must consider the document before an official vote
 - Parser in development – tentatively available for initial testing after Open Forum approval
- **Interested parties *strongly encouraged* to provide feedback and test models**
 - Feel free to provide or construct ICM models using “favorite interconnects” for testing
 - Example: package which is inconvenient or impossible to describe using IBIS .PKG



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Future Improvements

- **After 1.0 is approved by the Open Forum, several technical issues may be considered for future revisions**
 - Allow multiple types of data within a single [Begin ICM Model]/[End ICM Model] pair
 - Example: Include S-parameter AND RLGC data
 - Include frequency-dependence in RLGC data
 - Example: Matrix parameters for 1 MHz, 100 MHz, etc.
- **A formal “BIRD-like” procedure will be established to document and process change proposals**



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Long Term Issues

- **Using ICM with IBIS models**
 - No explicit links to IBIS in ICM or vice-versa
 - Implied that data files are linked through tools
 - IBIS or ICM BIRDs for cross-referencing?
- **Touchstone® and mixed-mode S-parameters**
 - ICM maps section nodes to ports
 - Ports are implied to be single-ended
 - Touchstone® format establishes regular data format
 - *Comments, options, frequency and S, Y, Z, H, G data*
 - *Interpretation of data assumes single-ended (S12, etc.)*
 - Mixed-mode (SDD12, SCD22, etc.)?
 - *Some authors release mixed-mode Touchstone® files*
 - *Data format is standard, but interpretation is not*
 - *New Touchstone needed for mixed-/multi-mode?*

Long Term Issues

- **ICM cookbook needed!**
 - Need to provide guidance to model builders
 - Take approach from 1997 IBIS 2.1 Cookbook
- **Cookbook topics**
 - Summary of keywords
 - Explanation of key concepts
 - *Ground references*
 - *Return paths*
 - Summary of best known modeling methods
 - *Measurement vs. simulation*
 - Several complete examples

Summary

- **ICM is an evolution of IBIS package and PCB modeling formats**
- **Official 1.0 pending Open Forum approval**
 - *Please review the ICM Final Draft*
 - *Comments and test models are appreciated!*
- **Thanks to the Connector Subcommittee**

John Angulo Arpad Muranyi
Kelly Green Augusto Panella
Lynne Green Stephen Peters
Bob Ross

**and to the many other individuals
and groups who contributed!**



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Questions and Free Discussion




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BACKUP

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S-parameter Data Formats

- **Single-ended**
 - Data defined per node + reference: S12, S21
- **Mixed-mode (usually differential pairs)**
 - Common & Differential excitation and response
 - Data defined per node pair: SDD12, SDD21
 - Data defined per node pair + reference: SCC11
- **“Multi-mode” (not covered by any spec.)**
 - Excitation and response for n-node groups
 - Example: $SD_{12}C_{458}$

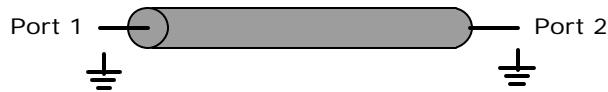
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S-parameter Data Formats

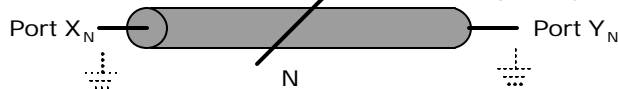
- **Single-ended**



- **Mixed-mode (usually differential pairs)**



- **“Multi-mode” (not covered by any spec.)**



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Touchstone® Variations

- **Spec. defines data placement convention**

```
! 4-port S-parameter data, taken at three frequency points
# GHZ S MA R 50
5.00000 0.60 161.24 0.40 -42.20 0.42 -66.58 0.53 -79.34 !row 1
```

4-port network description

```
<frequency value> <N11> <N12> <N13> <N14>
<N21> <N22> <N23> <N24>
<N31> <N32> <N33> <N34>
<N41> <N42> <N43> <N44>
```

- **Many model authors use general format, but define data placement through comments**

```
# MHz Y MA R 50
! Data is Freq SDD11 SDD12 SDD21 SDD22
! SCC11 SCC12 SCC21 SCC22
10 1.7784797E-01 -80.863279 1.7863314E-01 99.053834
3.8696562E-02 104.003821 3.8770346E-02 -76.072136
2.4735915E-07 151.207214 2.4624379E-07 -29.142657
3.1760443E-07 -166.479698 3.1562825E-07 13.585246
```

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ICM Example

```
[Begin Header]
[ICM Ver]           1.0
[File Name]         iconm_hdi_202.icm
[File Rev]          1.0
[Date]              May 29, 2003
[Source]            Results from field simulation
[Notes]             This is a test model only.
[Disclaimer]        This information is for modeling
                    purposes only, and is not guaranteed.
[Copyright]         Copyright 2003, XYZ Corp.,
                    All Rights Reserved
[Support]           http://www.VendorNameIbisModels.com
[Redistribution]     Yes
[Redistribution Text] This file is freely redistributable.
[End Header]
```



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ICM Example (2)

```
[Begin ICM Family]   High_Speed_Interconnect
[Manufacturer]       XYZ Incorporated
[ICM Family Description]
High Density square pin connector for use on IEEE 99999 buses.
|=====|
[ICM Model List]
| Name           Mating      Min_Slew_Time      Image
|-----|
My ModelExample3   Mated           100ps   HDI_202_Mated.jpg
|HDI_202_UnMatedA   Unmated_side_A 100ps   HDI_202_UnMatedA.jpg
|HDI_202_SMT_to_Cable Mated           25ps   HDI_TEST_202_Mated.jpg
|HDI_202_SMT_to_ThruHole Mated           25ps   HDI_202_Mated.jpg
|=====|
```




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ICM Example (3)

```

[Begin ICM Model] MyModelExample3           | Has a stub fork!

    ICM_Model_Type MLM
[Begin ICM Model Description]
High Density 0.1 center square pin with PCB effects

[Tree Path Description]


    Model_PinMap Baseboard_side
    Section Mult=1 SectionA
    Fork
        Section Mult=1 StubSection1
    End_fork
    Section Mult=1 SectionB
    Model_PinMap Output_side
[End ICM Model]

|                                     SectionA  SectionB
|                                     Baseboard_side >-----+-----< Output_side
|                                     |
|                                     | StubSection1

```

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ICM Example (4)

```

[ICM Pin Map] Baseboard_side
Pin_order = Row_ordered
Num_of_columns = 4
Num_of_rows = 2
Pin_list
|Pin  Name
  A1  PERR#
  A2  STOP
  A3  AD12
  A4  AD15
  B1  STOP
  B2  GND
  B3  PAR
  B4  GND

|[ICM Pin Map] Output_side omitted for clarity
[End ICM Family]

```

A1	A2	A3	A4
B1	B2	B3	B4

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ICM Example (5)

[Begin ICM Section] SectionA

[Derivation Method] Lumped

[Inductance Matrix] Full_matrix

[Row] 1

3.04859e-07 4.73185e-08 1.3428e-08 6.12191e-09

1.74022e-07 7.35469e-08 2.73201e-08 1.33807e-08

[Row] 2

3.04859e-07 4.73185e-08 1.3428e-08 7.35469e-08

1.74022e-07 7.35469e-08 2.73201e-08

|.

|.

|.



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ICM Example (6)

[Capacitance Matrix] Sparse_matrix

[Row] 1

1 2.48227e-10

2 -1.56651e-11

5 -9.54158e-11

6 -7.15684e-12

[Row] 2

2 2.51798e-10

3 -1.56552e-11

5 -6.85199e-12

6 -9.0486e-11

|.

|.

[End ICM Section]

| SectionB and StubSection1 omitted for clarity

[End]



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