

# IBIS Interconnect Modeling Specification (ICM) Status


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## Agenda

- ICM Refresher
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  - Structure
  - A Partial Example
- Recent History
- Changes in Final Draft 1.0
- Short Term Future
- The Longer View
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  - Touchstone® issues
  - Cookbook
- Summary
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  - S-parameter background
  - Improved Example Model

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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:  **$SD_{12}C_{458}$**

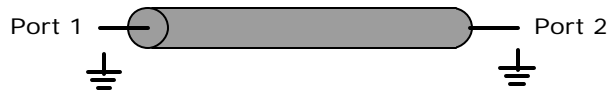
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## S-parameter Data Formats

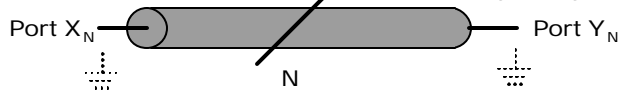
- **Single-ended**



- **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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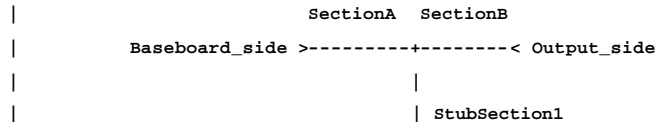
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## ICM Example (3)

```
[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]
```



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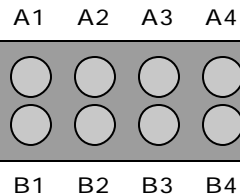


## ICM Example (4)

```
[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]
```

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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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