IBIS Interconnect Task Group Update

Touchstone 3.0 Features & Progress

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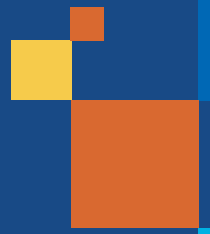
Some material presented at the Hybrid Asian IBIS Summit 2025, Tokyo and the Asian IBIS Summit 2024, Shanghai



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Touchstone History… and Gaps

More detailed history in "Touchstone Immediate and Long-Term Future" from 2023

- Touchstone format maintained by the IBIS Open Forum since 2007
  - Touchstone 1.1 (2002) – documented format from mid-1980s RF software
  - Touchstone 2.0 (2009) – added optional IBIS-like keywords for cross-checking
  - Touchstone 2.1 (2024) –corrections plus clarifications on per-port referencing

- Touchstone gaps identified by industry in the interconnect context
  - File compression not supported: large, fast networks cause unwieldy files
  - Connecting ports requires documentation: automation not supported

Touchstone 3.0 is being prepared to address these issues

Proposed Changes for Touchstone 3.0

- Touchstone Issue Resolution Documents
  - 7.2 Standardized Pole-Residue Representation
  - 8 Option line changes
  - (9) Standardized Port Mapping (WIP): Draft 29

The goal: balance usability by the wider industry (e.g., for RF and circuit purposes) with IBIS-specific features to help with package and system interconnect modeling

Pole-Residue for File Compression

Not shown…
[Begin Pole-Residue Data Source] /
[End Pole-Residue Data Source]

- A coefficients example, where data corresponds to [α_m ω_m A_m B_m] complex pole and normalized residue pairs, respectively

```
[Number of Pole-Residue Indices] 10

[Begin Pole-Residue Data] (1,1) (2,2) (3,3) (4,4)
Delay = 1.26351e-09
Constant_at_infinity = 0.321123423421
Number_of_data_lines = 35
1.60981891e+08 6.038300e+09 -2.15363238e-06 1.96534688e-05
2.93321810e+09 1.917708e+09 -1.05426912e+01 -8.82630433e+00
1.23990373e+08 4.399943e+09 1.257286128e-05 2.13669372e-05
...
5.23409852e+06 1.345345e+07 3.073147044e-06 5.16091015e-06
[End Pole-Residue Data]

| Additional data pairs follow…
```

Alternately, a pair of keywords may be used:

Common Poles Data
- All matrix elements share the same poles
- Just one per set model file

Residues Data
- Defines data for individual pairs
- Also includes the same subparameters

The data is meant for use in a single equation shown here for one (row, column) element…

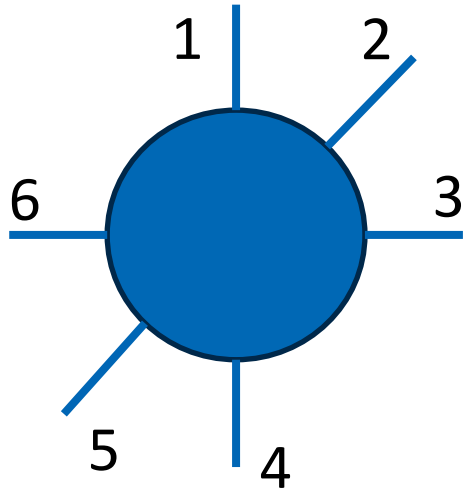
$$H(if) = \mathrm{e}^{-i2\pi fD}\left\{H_0 + \frac{1}{2}\sum_{m=1}^{M}\left[\frac{A_m - iB_m}{1+if/(\alpha_m + i\omega_m)} + \frac{A_m + iB_m}{1+if/(\alpha_m - i\omega_m)}\right]\right\} + ifG$$

This format is understood and used, with variations, by several existing industry tools.

This change to Touchstone has already been approved – 10-100x compression!

The Port-Mapping Problem

- In current Touchstone, what can we say about this component?
  - Interconnect or device?
  - If interconnect, what is the relationship between terminals?
  - Can I make inferences from the data?
  - What is the referencing scheme (how do terminals become ports?
- For interconnects, we need to know the terminal arrangement to focus properly on losses, crosstalk and the like
  - Is S21 insertion loss? Or is S21 crosstalk?



 # MHz Y RI R 50

5.00 8.0 9.0 2.0 -1.0 3.0 -2.0 1.0 3.0 1.0 0.1 0.2 -0.2

2.0 -1.0 7.0 7.0 1.8 -2.0 -1.0 -1.0 -0.5 0.5 0.2 -0.1

3.0 -2.0 1.8 -2.0 5.8 6.0 1.2 0.8 0.9 0.7 0.3 -0.5

1.0 3.0 -1.0 -1.0 1.2 0.8 6.3 8.0 2.0 -0.5 1.5 0.6

1.0 0.1 -0.5 0.5 0.9 0.7 2.0 -0.5 4.7 -6.0 -1.0 2.0

0.2 -0.2 0.2 -0.1 0.3 -0.5 1.5 0.6 -1.0 2.0 5.5 -7.0

For interconnects, need a structure that establishes expectations for terminal behavior automatically and in advance of detailed data analysis

Port-Mapping WIP Syntax for Touchstone 3.0

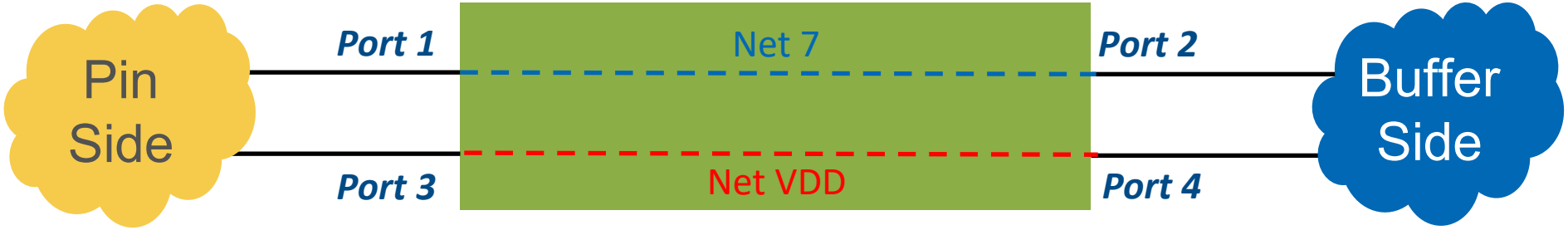
```
[Begin Port Map]
|
Data_usage "IBIS_Interconnect"
Port 1 (Physical pin.7)              (Type S)(Side Pin)     (Net 7)   (Logical DQ3pin)
Port 2 (Physical buf.7)              (Type S)(Side Buffer)  (Net 7)   (Logical DQ3buffer)
Port 3 (Physical Pin.Bus_label:VDD)  (Type P)(Side Pin)     (Net VDD)(Logical VDDpin)
Port 4 (Physical Pullup_ref.7)       (Type P)(Side Buffer)  (Net VDD)(Logical VDDbuffer)
Symbol_leftside 1 3
Symbol_rightside 2 4
|
[End Port Map]
```

Data_usage is optional, and supports IBIS structures EMD, C_comp_model and Ts4file as well

Reference and Diff_Port identifiers are also available

A port is a pair of terminals. The reference terminal is A_gnd for all ports in this example.

DQ3 and VDD from pin to buffer



Physical and Net provide connectivity guidance;

All other identifiers are informative (e.g., for schematic symbols)

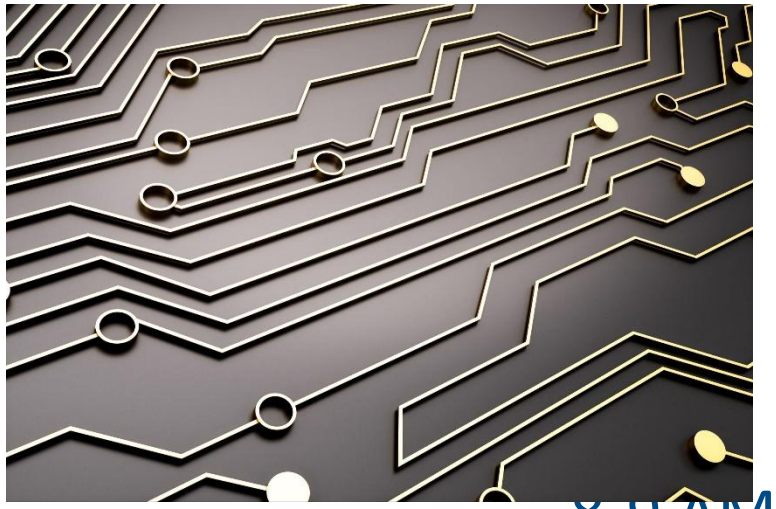
Our Request to the Community

- Touchstone 3.0 is targeting the two major
  - Reduce file sizes
  - Support port-mapping for automated connections
- Do these changes address your needs?
  - If not, what features are missing?
- What test cases would you need to evaluate Touchstone 3.0?
  - What examples should be part of the standard?

Please review the documents and provide comments!

Backup

Who Is The IBIS Interconnect Task Group?



- Designs and writes technical changes support passive interconnect formats
  - Supports IBIS, Touchstone and IBIS-ISS
  - Live teleconferences are held Wednesdays 8-9 AM US Pacific Time
  - Web site: https://ibis.org/interconnect_wip/
  - Freelists is the most up-to-date source for documents and discussion:
  - https://freelists.org/archive/ibis-interconn/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