**BUFFER ISSUE RESOLUTION DOCUMENT (BIRD)**

**BIRD NUMBER:** 232

**ISSUE TITLE:** Clarification of Ts4file and Non-AMI Feature Relationships

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**DATE SUBMITTED:** November 19, 2024

**DATE REVISED:**

**DATE ACCEPTED:** February 21, 2024

**DEFINITION OF THE ISSUE:**

Several aspects of the Ts4file parameters for IBIS AMI models overlap with existing structures in “traditional” IBIS; these include [Ramp], C\_comp and associated keywords, the I-V table keywords, and the [External Model] keyword. In particular, the meaning of [Ramp] when Ts4file is present is ambiguous in the existing IBIS text. This has led to inconsistent parser behavior, as well as various interpretations of the use of [Ramp] in IBIS AMI contexts, including as a description of buffer stimulus rather than buffer output.

In addition, the meaning and use of the Tx\_R and Rx\_R structures in the existing Ts4file text is unclear, potentially leading to misunderstandings of how to generate Ts4file data.

**SOLUTION REQUIREMENTS:**

The IBIS specification must meet these requirements:

Table : Solution Requirements

|  |  |
| --- | --- |
| Requirement | Notes |
| 1. Clearly state the purpose of [Ramp] in the presence of Ts4file and [External Model]
 |  |
| 1. Clearly state which keywords and parameters are permitted or prohibited when Ts4file is used
 |  |
| 1. Explain the meaning and use of Tx\_R and Rx\_R parameter data
 |  |

**SUMMARY OF PROPOSED CHANGES:**

For review purposes, the proposed changes are summarized as follows:

Table : IBIS Keywords, Subparameters, AMI Reserved\_Parameters, and AMI functions Affected

|  |  |  |
| --- | --- | --- |
| Specification Item | New/Modified/Other | Notes |
| Expand the original [Ramp] keyword text to prohibit its use as buffer stimulus, and explain whether/how it should be compared to other IBIS data, particularly Ts4file  | New |  |
| Remove language about [Ramp] being replaced by [External Model] and clarify [Ramp] relationship to [External Model] | Modified |  |
| Clarify which traditional IBIS keywords are affected by Ts4file | Modified |  |
| Add language clarifying how Tx\_R and Rx\_R interact with the Touchstone file used in Ts4file | New |  |

**PROPOSED CHANGES:**

All page numbers below correspond to the IBIS 7.2 document in Adobe\* PDF format.

On page 104, modify the text at the end of the “Description” for [Ramp] as shown below:

“The ramp rate does not include packaging but does include the effects of the C\_comp or C\_comp\_\* parameters, and the [C Comp Corner] and [C Comp Model] keywords.”

On page 104, add the following text immediately before the [Ramp] example:

*“Other Notes*: [Ramp] is intended to describe the loaded output buffer behavior. It does not, in any context, represent the stimulus to the buffer. Ideally, [Ramp] should be consistent with all other IBIS methods of describing the transmitter buffer behavior. However, cross-checking these may not always be possible without simulation (this is particularly true for the [External Model] keyword). [Ramp] dV data should be consistent with any [Pullup], [Pulldown], [POWER Clamp] and [GND Clamp] data provided for the same [Model]. Similarly, [Ramp] dV and dt data should be consistent with the [Rising Waveform] and/or [Falling Waveform] data provided, if their loading conditions are identical or convertible. [Ramp] should be consistent with the behavior of data provided in the Ts4file parameter if present in an associated .ami file, under identical loading conditions.”

On page 130, modify the text as shown below:

“Thus, the [External Model] keyword can be used to replace the usual I-V and V-T tables, C\_comp, C\_comp\_pullup, C\_comp\_pulldown, C\_comp\_power\_clamp, C\_comp\_gnd\_clamp subparameters, [C Comp Corner], [C Comp Model], ~~[Ramp]~~, [Driver Schedule], [Submodel] keywords, etc. of a [Model] by any modeling technique that the external languages allow.”

Modify the text on pages 136-137 as shown below:

“In models without the [External Model] keyword, data for [Ramp] should be measured using a load that conforms to the recommendations in Section 9, “NOTES ON DATA DERIVATION METHOD”. ~~However, w~~ When used within the scope of [External Model], the [Ramp] keyword is intended strictly to provide EDA tools with a quick first-order estimate of driver switching characteristics. When using [External Model], therefore, data for [Ramp] may be measured using a different load, if it results in data that better represent the driver’s behavior in standard operation. ~~Also, in this case, the R\_load subparameter is optional, regardless of its value, and will be ignored by EDA tools.~~ For example, the 20% to 80% voltage and time intervals for a differential buffer may be measured using the typical differential operating load appropriate to that buffer’s technology.”

Modify the first paragraph of Section 10.10 on page 315 as shown below:

“This section discusses an optional ~~alternative~~ analog buffer modeling technique, specifically designed for AMI applications (to be used in channel characterization simulations to generate the channel impulse response, as input to the algorithmic analysis). The approach uses 4-port ~~analog circuit~~ network data as an alternative to the model information used in the C\_comp subparameter and the [Ramp], [Pullup], [Pulldown], [GND Clamp], [POWER Clamp], [Rising Waveform], [Falling Waveform], [C Comp Corner] and/or [C Comp Model] keywords. This data is provided in a Touchstone scattering parameters file specified by the AMI parameter named Ts4file (note: Ts4file implies a restricted Touchstone format, where the number of ports is four and the port numbering is predefined). Note that the presence of [Ramp] is still required when Ts4file is present, but that Ts4file effectively replaces most [Model] behavioral description keywords and parameters. [Ramp], any [Rising Waveform] and/or [Falling Waveform] keywords, and any [Pullup], [Pulldown], [GND Clamp], and/or [POWER Clamp] keywords (if present) should be consistent with the output behavior of the buffer, including when Ts4file is present, under identical loading conditions.”

Add at end of the second paragraph of Section 10.10.1 on page 315:

“Note that Tx\_R is optional; when non-zero, it represents part of the actual transmitter impedance. If omitted, the entire impedance of the transmitter is assumed represented by the Touchstone S-parameter file contents identified by Ts4file.”

Add at the end of second paragraph of Section 10.10.2 on page 316:

"Note that Rx\_R is optional; when present, it represents part of the actual receiver impedance. If omitted, the entire impedance of the receiver is assumed represented by the Touchstone S-parameter file contents identified by Ts4file "

Insert the following text before the final paragraph on page 316:

“The following keywords and subparameters may be omitted, regardless of Model\_type, from a [Model] which uses [Algorithmic Model] data that includes the Ts4file parameter:

C\_comp, C\_comp\_pullup, C\_comp\_pulldown, C\_comp\_power\_clamp, C\_comp\_gnd\_clamp, [C Comp Model], [Pullup], [Pulldown], [POWER Clamp], [GND Clamp]

The following keywords and subparameters are required in such a model:

 Model\_type, [Ramp], [Voltage Range] (or alternately [Pullup Reference], [POWER Clamp Reference], [Pulldown Reference], and [GND Clamp Reference])”

**BACKGROUND INFORMATION/HISTORY:**

This BIRD was extensively discussed in and modified by the IBIS Advanced Technology Modeling Task Group across several months in 2024. Significant editorial guidance was provided by Arpad Muranyi of Siemens EDA.