**BUFFER ISSUE RESOLUTION DOCUMENT (BIRD)**

**BIRD NUMBER: (Draft 4)**

**ISSUE TITLE:** Rx Deterministic Noise Support for AMI

**REQUESTOR:**  Michael Mirmak, Intel Corp.

**DATE SUBMITTED:** Draft 4 – Dec. 6, 2016

**DATE REVISED:**

**DATE ACCEPTED:**

**DEFINITION OF THE ISSUE:**

IBIS 6.1 defines separate deterministic (uniform) and random (Gaussian) jitter Reserved Parameters for Tx and Rx devices as Tx\_Dj, Tx\_Rj, Rx\_Dj and Rx\_Rj, respectively. However, the receiver noise Reserved Parameter Rx\_Noise covers only random (unbounded Gaussian) noise. A more complete definition of receiver noise would include a parameter for deterministic (bounded uniform) noise, and would ideally use names for both noise parameters that parallel the naming convention for jitter.

**SOLUTION REQUIREMENTS:**

The IBIS specification must meet these requirements:

Table 1: Solution Requirements

|  |  |
| --- | --- |
| Requirement | Notes |
| 1. Deterministic (bounded uniform) Rx Noise must be supported by IBIS-AMI, separately from the existing Gaussian random Rx Noise parameter.
 |  |
| 1. The existing Rx\_Noise Reserved Parameter must be clarified as referring to unbounded Gaussian random noise, as is already done for Tx\_Rj and Rx\_Rj.
 |  |
| 1. The ranges for the unbounded Gaussian and bounded uniform random multipliers of the noise value in the equations to be used by EDA tools should be clearly stated.
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**SUMMARY OF PROPOSED CHANGES:**

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

Table 2: IBIS Keywords, Subparameters, AMI Reserved\_Parameters, and AMI functions Affected

|  |  |  |
| --- | --- | --- |
| Specification Item | New/Modified/Other | Notes |
| The Reserved Parameter Rx\_UniformNoise is defined | New |  |
| The Reserved Parameter Rx\_GaussianNoise is added as an alternate name for Rx\_Noise. | Modified | This is a modification of the existing parameter Rx\_Noise, to clarify its relationship to the new Reserved Parameter Rx\_UniformNoise |
| The range for gaussian\_rand() and the meaning of the Rx\_Noise equation are clarified. | Other | The text of the Rx\_Noise parameter definition is clarified to define the range for gaussian\_rand(), with the output and input to the equations made explicit. |

**PROPOSED CHANGES:**

*The definition of Rx\_Noise on page 228 of the existing IBIS 6.1 specification should be changed from:*

*Parameter:* **Rx\_Noise**

*Required:* No, and illegal before AMI\_Version 6.0

*Direction:* Rx

*Descriptors*:

Usage: Info, Out, Dep

Type: Float

Format: Value, List, Range, Corner, Increment, Steps

Default: <numeric\_literal*>*

Description:<string>

*Definition:* The standard deviation, in volts, of a white Gaussian random process, which is to be added by the EDA tool to the signal measured at the sampling latch of a receiver.

*Usage Rules:* If Rx\_Noise is Usage Out, then the EDA tool shall use the value returned by Rx AMI\_Init if Rx AMI\_GetWave is not used. If Rx AMI\_GetWave is used, then the EDA tool may apply the value returned by each AMI\_GetWave call to the waveform returned by that call to AMI\_GetWave, or use the average value of Rx\_Noise returned by all calls to AMI\_GetWave (after Ignore\_Bits), or the value of Rx\_Noise returned by the last call to AMI\_GetWave.

*Other Notes:* Time is calculated as follows:

wave(t) = wave(t) + Rx\_Noise \* gaussian\_rand()

Where wave(t) is the waveform returned by Rx AMI\_GetWave.

*Example:*

 (Rx\_Noise (Usage Info) (Value 0.010) (Type Float)

 (Description "Rx amplitude noise at sampling latch in volts."))

*… to:*

*Parameter:* **Rx\_Noise, Rx\_GaussianNoise**

*Required:* No, and Rx\_Noise is illegal before AMI\_Version 6.0; Rx\_GaussianNoise is illegal before AMI\_Version 6.2

*Direction:* Rx

*Descriptors*:

Usage: Info, Out, Dep

Type: Float

Format: Value, List, Range, Corner, Increment, Steps

Default: <numeric\_literal*>*

Description:<string>

*Definition:* The standard deviation, in volts, of an unbounded white Gaussian random process, which is to be added by the EDA tool to the signal measured at the sampling latch of a receiver.

*Usage Rules:* If Rx\_Noise is Usage Out, then the EDA tool shall use the value returned by Rx AMI\_Init if Rx AMI\_GetWave is not used. If Rx AMI\_GetWave is used, then the EDA tool may apply the value returned by each AMI\_GetWave call to the waveform returned by that call to AMI\_GetWave, or use the average value of Rx\_Noise returned by all calls to AMI\_GetWave (after Ignore\_Bits), or the value of Rx\_Noise returned by the last call to AMI\_GetWave.

*Other Notes:* The output voltage waveform is calculated as follows:

Output\_wave(t) = wave(t) + Rx\_Noise \* gaussian\_rand()

Where wave(t) is the waveform returned by Rx AMI\_GetWave and gaussian\_rand() is a function that returns floating point numbers between -inf and +inf. The distribution of these numbers shall be a white Gaussian distribution centered at 0.0 with a standard deviation of 1.0.

Rx\_GaussianNoise is permitted as an alternate name for Rx\_Noise in AMI\_Version 6.2 and higher.

*Example:*

 (Rx\_Noise (Usage Info) (Value 0.010) (Type Float)

 (Description "Rx amplitude noise at sampling latch in volts."))

*Immediately after, a new Reserved Parameter should be added:*

*Parameter:* **Rx\_UniformNoise**

*Required:* No, and illegal before AMI\_Version 6.2

*Direction:* Rx

*Descriptors*:

Usage: Info, Out, Dep

Type: Float

Format: Value, List, Range, Corner, Increment, Steps

Default: <numeric\_literal*>*

Description:<string>

*Definition:* The worst-case half peak-to-peak variation, in volts, of a bounded uniform random process which is to be added by the EDA tool to the signal measured at the sampling latch of a receiver.

*Usage Rules:* If Rx\_UniformNoise is Usage Out, then the EDA tool shall use the value returned by Rx AMI\_Init if Rx AMI\_GetWave is not used. If Rx AMI\_GetWave is used, then the EDA tool may apply the value returned by each AMI\_GetWave call to the waveform returned by that call to AMI\_GetWave, or use the average value of Rx\_UniformNoise returned by all calls to AMI\_GetWave (after Ignore\_Bits), or the value of Rx\_UniformNoise returned by the last call to AMI\_GetWave.

*Other Notes:* The output voltage waveform is calculated as follows:

Output\_wave(t) = wave(t) + 2 \* Rx\_UniformNoise \* rand()

Where wave(t) is the waveform returned by Rx AMI\_GetWave and rand() is a function that returns floating point numbers between -0.5 and +0.5 with white uniform distribution.

*Example:*

 (Rx\_UniformNoise (Usage Info) (Value 0.010) (Type Float)

 (Description "Rx deterministic amplitude noise at sampling latch in volts."))

**BACKGROUND INFORMATION/HISTORY:**

This was submitted by Michael Mirmak of Intel Corp. as a draft for review by the IBIS Advanced Technology Modeling Task Group on November 10, 2016.

Draft 2 changes the names of Rx\_Dn and Rx\_Rn to Rx\_BoundedUniform and Rx\_Gaussian, at the suggestion of participants in the IBIS-ATM Task Group.

Draft 3 changes the names of Rx\_BoundedUniform and Rx\_Gaussian to Rx\_BoundedUniformNoise and Rx\_UnboundedGaussianNoise, respectively, at the suggestion of participants in the IBIS-ATM Task Group.

Draft 4 changes the names of Rx\_BoundedUniform and Rx\_Gaussian to Rx\_UniformNoise and Rx\_GaussianNoise, respectively, at the suggestion of participants in the IBIS-ATM Task Group.