**BUFFER ISSUE RESOLUTION DOCUMENT (BIRD)**

**BIRD NUMBER: 168.1**

**ISSUE TITLE:** *Handling of Overclocking Caused by Delay in Waveform Tables*

**REQUESTOR:**  *Radek Biernacki and Ming Yan, Agilent Technologies, Inc.;*

 *Justin Butterfield and Randy Wolff, Micron Technology, Inc.*

**DATE SUBMITTED:** *April 22, 2014*

**DATE REVISED:** *June 20, 2014*

**DATE ACCEPTED BY IBIS OPEN FORUM:** *June 20, 2014*

**STATEMENT OF THE ISSUE:**

*Some EDA vendors allow user-specified truncation of initial delay in the V-t tables and/or in the Composite Current tables. Other EDA vendors may use arbitrary “windowing” techniques while some may not allow any similar actions. This leads to inconsistent simulation results across different EDA tools. The authors of this BIRD believe that only IBIS model developers have the appropriate knowledge to specify the exact amount of the initial delay that can and in fact should be properly removed from the waveform tables. The model developers should then communicate it for a proper and consistent model simulation. This BIRD does not address true overclocking where the user attempts simulation of a buffer at switching rates exceeding hardware capabilities.*

**ANALYSIS PATH/DATA THAT LED TO SPECIFICATION:**

*When using an IBIS transmitter model (e.g., an output model or an I/O model in the output mode), the user is free to set the bit rate of the trigger signal. If the bit rate is too high then a trigger event may happen before the previous transition (rising or falling) is finished. This is commonly referred to as overclocking. The specification rightfully does not provide any guidance to how the EDA platforms should handle overclocking. However, with the introduction of BIRD95 and BIRD98 to address pre-driver current consumption, model makers started adding additional delay at the beginning of the V-t tables and the [Composite Current] tables. Such a delay is only necessary for time alignment of the voltage and current waveforms and effectively extends the duration of the rising and falling transitions, while the buffer circuitry remains capable of faster switching than that determined by the duration of the waveform tables.*

**ANY OTHER BACKGROUND INFORMATION:**

See the following relevant presentations and publications.

1. [*http://www.eda-stds.org/ibis/summits/jan14/sun.pdf*](http://www.eda-stds.org/ibis/summits/jan14/sun.pdf) (see also [*http://www.eda.org/ibis/summits/nov13c/sun.pdf*](http://www.eda.org/ibis/summits/nov13c/sun.pdf) )
2. [*http://www.eda.org/ibis/summits/nov12c/torigoshi.pdf*](http://www.eda.org/ibis/summits/nov12c/torigoshi.pdf)
3. [*http://www.siconsultant.com/press\_kit/engineers\_guide\_to\_hacking\_ibis\_models.pdf*](http://www.siconsultant.com/press_kit/engineers_guide_to_hacking_ibis_models.pdf)

The BIRD was approved with changes at the June 20, 2014 IBIS Open Forum teleconference, and posted as 168.1.

A new keyword is proposed under the [Model] keyword in Section 6. A corresponding modification to Section 3A “KEYWORD HIERARCHY” needs to be added as well.

Add the following new keyword under the [Model] keyword:

*Keyword:* **[Initial\_Delay]**

*Required:* No

*Description:* Initial delay added to waveform tables.

*Sub-Params:* V-T, I-T

*Usage Rules:* The [Initial\_Delay] keyword can be specified only when at least one waveform table (Rising Waveform, Falling Waveform, or Composite Current) is included for the IBIS model under which this keyword is specified. The V-T subparameter can be specified only when at least one voltage waveform table (Rising Waveform or Falling Waveform) is specified. It applies to all the voltage waveforms present. The I-T subparameter can be specified only when at least one current waveform table (Composite Current) is specified. It applies to all the current waveforms present. Only one [Initial\_Delay] keyword can be specified for a model. It shall be followed by either one subparameter or both subparameters. Data specified for a subparameter shall be handled as described below.

*Other Notes:* Each subparameter shall be followed by three non-negative floating point numbers representing the typ, min and max amounts of time delay in seconds. For the second and/or the third number NA can be specified. The meaning of the NA entry is equivalent to entering the same value as in the “typ’ column (the first value following the subparameter name). The typ, min and max values are defined for the respective typ, min and max columns of the corresponding waveform tables.

*EDA tool handling of Initial\_Delay data:* Following user selection of the typ/min/max corner the EDA tool shall apply the value τV given in the corresponding column of the V-T subparameter to (1) modifying all the voltage waveform tables by subtracting τV from each value in the “time” column of the table, and (2) delaying every trigger event applied to the buffer by τV when any of the voltage waveform tables is to be used. Following user selection of the typ/min/max corner the EDA tool shall apply the value τCC given in the corresponding column of the I-T subparameter to (1) modifying all the current waveform tables by subtracting τCC from each value in the “time” column of the table, and (2) delaying every trigger event applied to the buffer by τCC when any of the current waveform tables is to be used. When both subparameters are specified and the values τV and τCC are identical any single trigger event applied to the buffer becomes simply delayed. When both subparameters are specified and the values τV and τCC are different any single trigger event applied to the buffer is split to create two separately delayed trigger events that are applied independently to either the voltage waveform data or to the current waveform data. For IBIS files with [IBIS Ver] 6.1 or higher, if the delay information is missing (the [Initial\_Delay] keyword is not specified or when it is specified the subparameter(s) corresponding to the table(s) that is/are present is/are not specified) the assumption is that the corresponding delay value(s) (τV and/or τCC) is/are zero.

*Example:*

[Initial Delay] | This keyword provides information on removable delay(s)

| time table typ min max

 V-T 0.20e-9 0.22e-9 0.18e-9

 I-T 0.05e-9 NA NA