

# **TUSB546 IBIS-AMI Models**

## ***User's Guide***

Version 00.01.00

23 May 2017

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# 1 Introduction

This document describes the organization, structure, and proper usage of the TI TUSB546 IBIS-AMI models (compiled and approved for external customer release), hereafter referred to as the “model” for short. The model is intended for use by the TUSB546 design team and by TUSB546 customers for system-level modeling and verification. This document assumes that you are familiar with the relevant IBIS-AMI modeling specifications.

## 1.1 Formatting Conventions

The help readability, various formatting conventions are used throughout this document:

- Hyperlinks to material within and outside this document are marked in [blue](#).
- Courier font is used for `file names`, `code`, `variables`, `structures`, `parameters`, and `terminal commands`.

## 1.2 Charter of the SerDes IBIS-AMI models

The models are designed in accordance with the [IBIS-AMI standard](#) and attempt to model the significant characteristics of most components in the TUSB546. The models are not intended to be an exact representation of TUSB546 components implemented. Rather, the models seek to provide as high a degree of accuracy as is feasible outside of Spice-based models and simulations.

## 1.3 Is / Is Not Table

The following table describes the features and purposes of the models, as well as the limitations of the models.

**Table 1: Model Is / Is Not Table**

<b>Is</b>	<b>Is Not</b>
Compiled for 32-bit and 64 bit AMI EDA tool that run in Windows platform Compiled for 64-bit AMI EDA tool that run in Linux platform	Compiled for any other platform (i.e. 32-Linux)
Compliant to IBIS-AMI 5.0	Compliant to a more recent BIRD revisions, if they exist
<i>Model of TUSB546 functionality, non-idealities, and performance</i>	<i>Exact representation of implemented components</i>

The TI IBIS-AMI models contain information on products that is based on high-level specifications. These may not accurately represent the product design in all cases. Please verify the accuracy of the models with TI before using the results.

## 2 About This Release

### 2.1 IBIS-AMI Model Files

Table 2 shows the key IBIS-AMI model files delivered with the model release as part of the compressed archive.

Table 2: IBIS-AMI files included with the model release

File Name	Type	Description
TUSB546_AMI_users_guide.pdf	PDF	TI TUSB546 AMI model user's guide.
tusb546_rxtx2.ibs	IBIS	Top-level IBIS wrapper for the Tx and Rx AMI model.
tusb546_tx_v1.ami	AMI	Parameters file for the Tx model as required by the IBIS-AMI standard. This is a text file which is common for all OS/execution platforms.
tusb546_tx_v1.dll tusb546_tx_v1_x64.dll	DLL	Windows 32-bit/64-bit compiled shared library for the Tx model. This shared library includes the AMI_Init, AMI_GetWave, and AMI_Close functions defined in the IBIS-AMI standard.
tusb546_rx2.ami	AMI	Parameters file for the Rx model as required by the IBIS-AMI standard. This is a text file which is common for all OS/execution platforms.
tusb546_rx2.dll tusb546_rx2.dll	DLL	Windows 32-bit/64-bit compiled shared library for the Rx model. This shared library includes the AMI_Init, AMI_GetWave, and AMI_Close functions defined in the IBIS-AMI standard.
dp_out_term.s4p	s4p	Driver terminations to capture the output reflection and cross-couple signal between differential pair. Please use this termination for <b>DP data path</b> .
dp_in_term.s4p	s4p	Input termination for input differential pair. Please use this termination for <b>DP data path</b> .
usb_tx_out_term.s4p	s4p	Driver terminations to capture the output reflection and cross-couple signal between differential pair. Please use this termination for <b>USB TX data path</b> .
usb_tx_in_term.s4p	s4p	Input termination for input differential pair. Please use this termination for <b>USB TX data path</b> .
usb_rx_out_term.s4p	s4p	Driver terminations to capture the output reflection and cross-couple signal between differential pair. Please use this termination for <b>USB RX data path</b> .

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usb_rx_in_term.s4p	s4p	Input termination for input differential pair. Please use this termination for <b>USB RX data path</b> .
TUSB546_ADS_release.7zads		Archieved ADS.7zads that contains a simple testbench in ADS.

## 2.2 DE and EQ AMI model specific parameters

TUSB546 model consists of receiver and transmitter models. EDA tool is responsible for casecading the receiver to the transmitter to form a redriver to perform signal integrity analysis.

The following tables corresponding to Equalization and Deemphasis parameter settings.

**Table 3. Model Specific Parameters for Receiver**

Parameter	Description and Setting
eq	0 to 15. Control the receiver equalization amount. Please see Table 3.1-3.3 for detail. Please note due to the nature of linear redriver, equalization setting will impact the driver characteristic as well.
path	0 to 2 Data path direction: path = 0: DP data path, e.g. DP0 to RX2 path = 1: USB TX data path e.g. SSTX to TX1 path = 2: USB RX data path, e.g. RX1 to SSRX

**Table 3.1 eq setting for DP data path, (path=0)**

eq	Gain at 4.05 GHz (dB)
0	1.0
1	3.3
2	4.9
3	6.5
4	7.5
5	8.6
6	9.5
7	10.4
8	11.1
9	11.7
10	12.3
11	12.8
12	13.2
13	13.6
14	14.0
15	14.4

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**Table 3.2 eq setting for USB TX data path, (path=1)**

eq	Gain at 2.5 GHz (dB)
0	0.2
1	1.2
2	2.2
3	3.3
4	4.2
5	5.1
6	5.9
7	6.7
8	7.4
9	8.1
10	8.7
11	9.3
12	9.7
13	10.2
14	10.6
15	11.1

**Table 3.3 eq setting for USB RX data path, (path=2)**

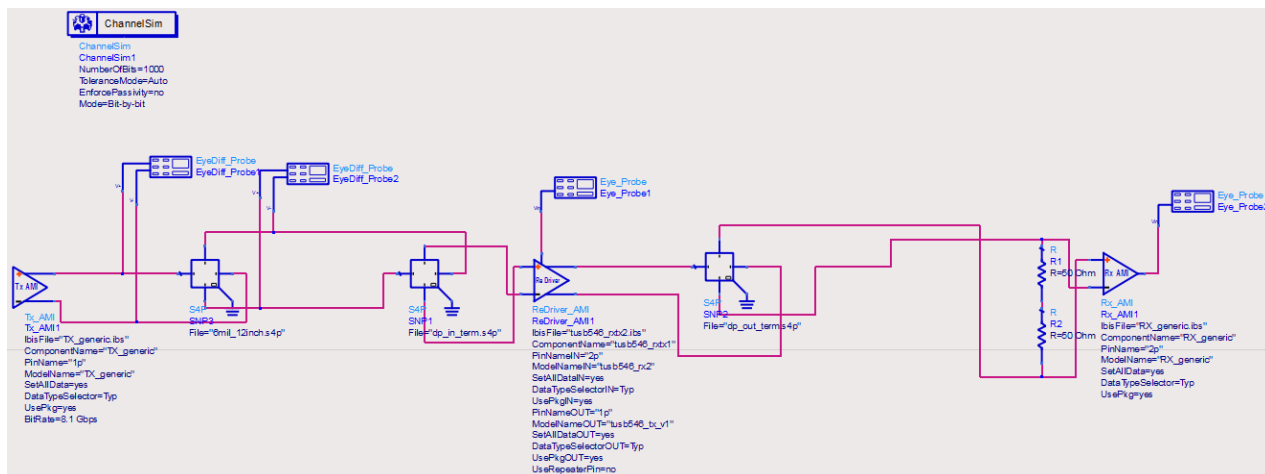
eq	Gain at 2.5 GHz (dB)
0	-1.6
1	-0.5
2	0.5
3	1.6
4	2.4
5	3.4
6	4.1
7	4.9
8	5.7
9	6.4
10	6.9
11	7.5
12	8.0
13	8.5
14	8.9
15	9.4

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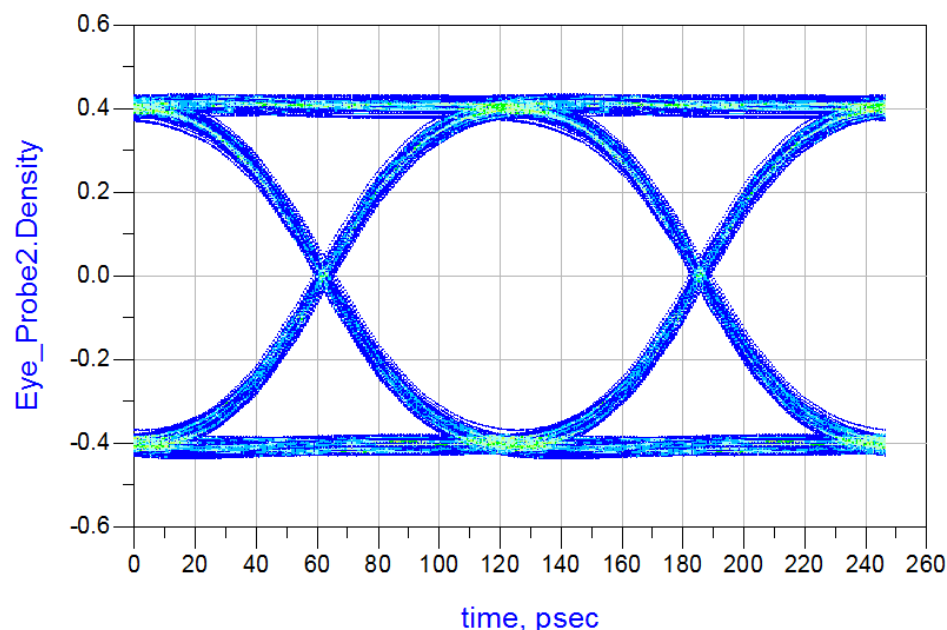
### 3 Model Simulation

**Figure 1. Schematic of a system that consists of ideal transmitter, TUSB546-DCI redriver, and ideal receiver.**



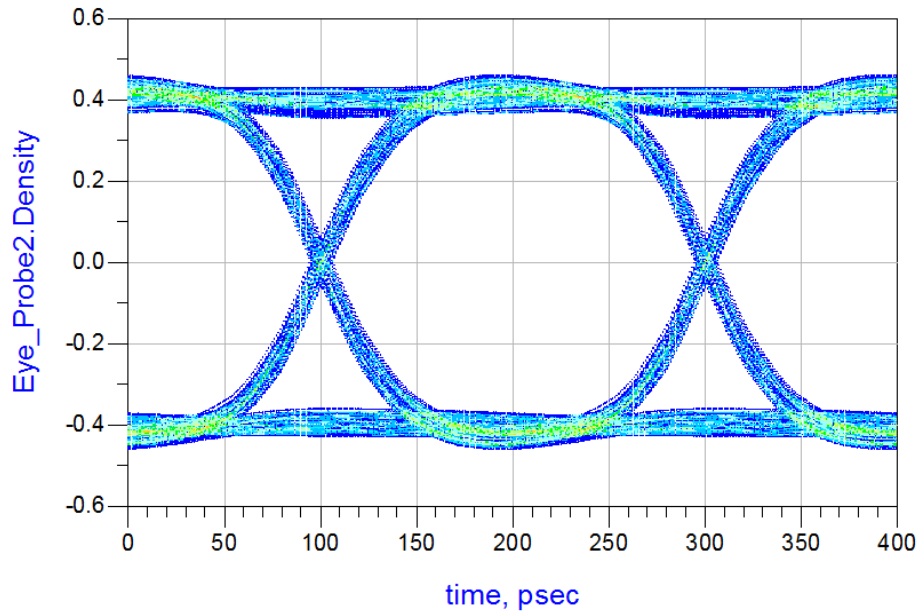
Please note that in ADS simulation set up , a user **MUST** choose “Enforce Passivity = no” option in order to observe correct behavior after driver termination, otherwise unrealistic signal amplitude degradation can be observed, which doesn’t reflect true driver behavior.

**Figure 2. 8.1Gbps DP data path simulation results with a 12-inch long 6-mil wide PCB trace at the input of TUSB546-DCI (Source: 1000mVpp, PRBS7, TUSB546-DCI EQ setting = 4)**



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**Figure 3. 5Gbps USB TX data path simulation results with a 12-inch long 6-mil wide PCB trace at the input of TUSB546-DCI (Source: 1000mVpp, PRBS7, TUSB546-DCI EQ setting = 4)**



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## 4 ADS Simulation Setup Guide

### 4.1 Introduction

This section provides an overview of running TI IBIS-AMI models using Agilent's Advance Design System Software. For instructions on how to install the software, please refer to Agilent's [Website](#).

### 4.2 Creating a new workspace

1. To create a new workspace in ADS, goto File -> New -> Workspace
2. Follow the new workspace wizard to create a new workspace
3. Enter the Project Name as 'XXXXX\_wrk'
4. Instantiate a new schematic from the created workspace
5. Name the cell as 'cell\_1' selecting the library as 'XXXXX\_lib'
6. You can follow the wizard or manually place parts to create your required test bench

### 4.3 Schematic Creation

1. To insert any part in ADS schematic, goto Insert -> Component -> Component Library
2. Use search box to search for your required components and drag them to schematic
3. Search for Tx\_AMI, Rx\_AMI to insert Transmitter and Receiver IBIS-AMI Models
4. Insert S data blocks to link S4P files for Analog Impairments and differential channels. Connect ground to the reference node.
5. Use ChannelSim component to create the required simulation environment
6. Insert eye probe to view the eye diagram, waveform and other measurements post simulation.
7. Create the schematic as shown in Figure 1 above

#### 4.4 Importing IBIS and AMI files

1. To import the ibis files in ADS, double Tx\_AMI or Rx\_AMI components on the schematic, and browse for the respective IBIS files
2. User can view details of IBIS model from various information tabs after selecting the IBIS files for transmitter and receiver
3. ADS automatically links the \*.ami and \*.dll files associated with the \*.ibs files

#### 4.5 Importing S-Parameter models

1. To import the S-parameter files, double click S4P block and browse for the required .s4p files to instantiate into the schematic.
2. Repeat this method for all S4P blocks to import various .s4p files
3. Rearrange the wiring between Tx\_AMI, S4P blocks and Rx\_AMI components to match the required port order w.r.t .sp4 file

#### 4.6 Simulation Settings

1. To access the simulation settings double click ChannelSim block.
2. User can change various simulation setting and parameters according to his need
3. Use help option to get detail understanding of various parameters
4. To run the simulation, goto simulate -> Simulate
5. Refer to simulation status popup for various simulation warnings and errors during simulation

#### 4.7 Simulation Results

1. Before running simulation, check for appropriate properties in eye probe for correct results
2. Set the data rate in parameters tab to the simulation bit rate as set in Tx\_AMI's PRBS tab
3. In measurements tab, include all the required measurement options required to be recorded
4. In the popup after simulation, insert rectangular plot from palette panel and link density measurement to view the eye diagram. Refer Figure 2.

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5. Use list from palette panel and link various other measurements in view in textual format