



Intel Agilex® 5 Device HSIO IBIS-AMI Models User Guide



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1.0 INTRODUCTION

Intel Agilex® 5 device HSIO IBIS-AMI models mainly model operation of the HSIO buffers with receiver equalization calibration feature, across different process, voltage, and temperature conditions.

Intel Agilex® 5 device support 2 types of receiver equalization calibration, which Continuous Time Linear Equalization (CTLE) and Decision Feedback Equalization (DFE). The CTLE can be turned on for all EMIF implementations except DDR5 and LPDDR5, however it is recommended to turn off the CTLE if you use pseudo-differential or true differential input buffer. The DFE can be turned on for the DDR5 and LPDDR5 data receiver to compensate for channel inter-symbol interference (ISI). The IBIS file has been tested and verified using commercial tools.

This document explains how to use the IBIS-AMI models in simulations and contains a list of all IBIS-AMI models that the existing version of the Intel Agilex® 5 device HSIO IBIS-AMI models support.

For more information about the CTLE and DFE, please refer to Programmable I/O Features Description topic in Intel Agilex® 5 General-Purpose I/O User Guide. Please also refer to the user guide for proper termination schemes as well as default settings (e.g., receiver equalization, OCT, etc....) for each I/O standard. The user guide can be obtained from Intel Website when available.

Please note that IBIS-AMI model is intended to target extreme operating conditions of Intel devices. Therefore, Min and Max corner settings in the IBIS-AMI model might defer from datasheet to consider package, die IR drop, and functional max value to avoid running into hold-time violations in simulation.



2.0 IBIS-AMI MODELS FILES INSTRUCTION

The IBIS file is currently using IBIS Specification v5.0. There are additional keywords that are supported in v5.0 but not in previous versions. Users are advised to use Visual IBIS Editor with IBIS specification of 5.0 onwards. This is to prevent any error which might be prompted from IBIS checker on updated keywords which are available in IBIS Specification v5.0 but are not backward compatible.

Package resistance, inductance, and capacitance (RLC) values that are currently defined under [Package] section in the IBIS file contains lumped RLC value for A5ED065BB32A package. For other packages model values, please refer to the **intel-agilex-5-device-pkg-rlc.xlsx** excel sheet which contains all supported packages for Intel Agilex® 5 device. The excel sheet can be obtained from Intel Website when available.

Behavior of the receiver equalization calibration feature is modelled algorithmically through executable model file (.dll file) and AMI parameter definition file (.ami file). The IBIS file includes references to the algorithmic models, by using [Algorithmic Model] and [End Algorithmic Model] keywords. The .dll files and the .ami files are resided in the same directory as the IBIS file.

There are separate .dll files and .ami files for each CTLE setting, which off, small, medium, and large. Besides that, each of the CTLE setting has 2 different modes, which high common mode and low common mode. Hence, there are total 8 .dll files and 8 .ami files for the CTLE. For the DFE, there are also separate .dll files and .ami files for each of the DDR5 and LPDDR5 mode. Hence, there are 2 .dll files and 2 .ami files for the DFE.

The CTLE and DFE are user configurable parameters, as specified in the .ami files. There are selections of on and off for the CTLE, user can select 0 to disable the CTLE while select 1 to enable it, the default is 1. There are also 2 selections for DFE, which adapt and off. Select 1 for auto equalization adaptation to obtain optimal DFE settings while select 0 to disable DFE, the default is 1. Besides the receiver equalization calibration feature, the IBIS-AMI models support both statistical and time-domain simulation modes.

The IBIS file contains multiple models. Please refer to section 3.0 below for details on models naming conventions.



3.0 NAMING NOMENCLATURE

All models follow naming method below:

</I/O standard>_</I/O>_<Feature1>_<Feature2>

where,

</I/O Standard> refers to:

sst12	-	SSTL-12
hst12	-	HSTL-12
hsul12	-	HSUL-12
pod12	-	POD12
pod11	-	POD11
lvst11	-	LVSTL11
lvst105	-	LVSTL105
lvst1700_105v	-	LVSTL700 1.05 V
dsst12	-	Differential SSTL-12
dhst12	-	Differential HSTL-12
dhsul12	-	Differential HSUL-12
dpod12	-	Differential POD12
dpod11	-	Differential POD11
dlvst11	-	Differential LVSTL11
dlvst105	-	Differential LVSTL105
dlvst1700_105v	-	Differential LVSTL700 1.05 V
slvs400_dphyhs_12v	-	SLVS-400/DPHY HS 1.2 V
slvs400_dphyhs_11v	-	SLVS-400/DPHY HS 1.1 V
tds13	-	True Differential Signaling 1.3 V
tds12	-	True Differential Signaling 1.2 V
tds11	-	True Differential Signaling 1.1 V
tds105	-	True Differential Signaling 1.05 V

</I/O> refers to:

in - Input pin

<Feature1> or **<Feature2>** refers to:

e0	-	CTLE off
e1	-	CTLE small
e2	-	CTLE medium
e3	-	CTLE large
g50	-	50ohm parallel on-chip termination without calibration
g40c	-	40ohm parallel on-chip termination with calibration
g50c	-	50ohm parallel on-chip termination with calibration
g60c	-	60ohm parallel on-chip termination with calibration
t100c	-	100ohm differential on-chip termination with calibration
t100	-	100ohm differential on-chip termination without calibration

Example: pod11_in_g40c refers to POD11 input buffer with DFE and 40ohm parallel on-chip termination with calibration.



4.0 LIST OF INTEL AGILEX® 5 DEVICE HSIO IBIS-AMI MODELS

HSIO_AMI_Model_List worksheet in **intel-agilex-5-device-model-list.xlsx** excel sheet contains all supported models for the Intel Agilex® 5 device HSIO IBIS-AMI models version 1.0. The excel sheet can be obtained from Intel Website when available.



5.0 INTEL AGILEX® 5 DEVICE HSIO IBIS (IBIS-AMI) FILE REVISION HISTORY

Date	Version	Description
March 2024	1.0	Preliminary release. Subject to change.



6.0 INTEL AGILEX® 5 DEVICE HSIO IBIS-AMI MODELS USER GUIDE REVISION HISTORY

Date	Version	Description
March 2024	1.0	Initial release of the Intel Agilex® 5 Device HSIO IBIS-AMI Models User Guide