

User's Guide

TDP1204 IBIS-AMI Model User's Guide



ABSTRACT

This document provides an IBIS-AMI model reference for the TDP1204 HDMI 2.1 redriver. It contains detailed information related to the TDP1204 IBIS-AMI model. The intended audience includes engineers working on signal integrity simulations.

It is recommended that the reader be familiar with the [TDP1204 12-Gbps, DC or AC-Coupled to HDMI™ 2.1 Level Shifter Hybrid Redriver Data Sheet](#). This document and all other collateral data related to the TDP1204 redriver (application notes, programming guides, models, and so forth) are available to download from TI website. Alternatively, contact your local Texas Instruments field sales representative.

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1 Overview

This document is an IBIS-AMI Model User's Guide for the TDP1204 HDMI2.1 redriver. [Table 1-1](#) lists pertinent information related to the model.

Table 1-1. Model Information

Item	Value / Comment
TI Device	TDP1204
IBIS Model Version	Compliant to IBIS Version 6.0
Supported Platforms	<ul style="list-style-type: none"> 64-Bit Windows 64-bit Linux
Process	Nominal process
Temperature	Room temperature (25°C)
Supply	Nominal supply (3.3V)
VOD support	Dx_VOD = 1, 3, 5
Tx De-emphasis	Dx_TXFFE = 0, 4, 5, 6, 7. Supported only in TDP1204_FRL.ibs. The TDP1204_TMDS.ibs does not support de-emphasis or pre-emphasis.
TERM support	TERM = 0. Supported only in TDP1204_TMDS.ibs. Use tx_term_NT.s4p. TERM = 1. Supported only in TDP1204_TMDS.ibs. Use tx_term_300.s4p TERM = 3. Use tx_term_100.s4p
8G, 10G, and 12G Slew rate support	SLEW_8G10G12G = 6, 7. Supported only in TDP1204_FRL.ibs.
6G Slew rate support	SLEW_6G = 3, 4, 5. Supported only in TDP1204_TMDS.ibs.
3G Slew rate	SLEW_3G = 2, 3, 4. Supported only in TDP1204_TMDS.ibs.
DC Gain Support	GLOBAL_DCG = 2
3G CTLE	CTLE_SEL = 0. Supported only in TDP1204_TMDS.ibs.
6G CTLE	CTLE_SEL = 1. Supported only in TDP1204_TMDS.ibs.
12G CTLE	CTLE_SEL = 2. Supported only in TDP1204_FRL.ibs.
EQ support	Dx_EQ: 0 through 15

Table 1-2. IBIS-AMI Files for TDP1204_FRL.ibs

File Name	Description
TDP1204_FRL.ibis	Top-level IBIS wrapper
Redriver_FRL_Signal_path.ami	Parameters file for complete TDP1204 model as required by the IBIS-AMI standard. This is a text file that is common for all OS/execution platforms.
Redriver_FRL_Signal_Path_x64.dll	Windows 64-bit compiled shared library for the "Rx model". This shared library includes the AMI_Init, AMI_GetWave.
Redriver_FRL_Signal_Path_x64.so	Linux 64-bit compiled shared object library for the "Rx model". This shared library includes the AMI_Init, AMI_GetWave.
Thru.ami	Parameters file for the "tx model" as required by the IBIS-AMI standard. This file is needed to complete the redriver component
Thru_x64.dll	Windows 64-bit compiled shared library for the "TX model". This file is needed to complete the redriver component.
Thru_x64.so	Linux 64-bit compiled shared library for the "TX model". This file is needed to complete the redriver component.
rx_term.s4p	Input termination and package. Captures the input reflection and coupling between input differential pair.
tx_term_100.s4p	TX driver 100-Ω differential termination and package. Use in HDMI 2.0 and 2.1 datarates.
TDP1204_IBIS_AMI_wrk.7zads	ADS archive of a sample test bench for the different modes of operation.

Table 1-3. IBIS-AMI Files for TDP1204_TMDS.ibs

File Name	Description
TDP1204_TMDS.ibis	Top-level IBIS wrapper

Table 1-3. IBIS-AMI Files for TDP1204_TMD5.ibs (continued)

File Name	Description
Redriver_TMD5_Signal_path.ami	Parameters file for complete TDP1204 model as required by the IBIS-AMI standard. This is a text file that is common for all OS/execution platforms.
Redriver_TMD5_Signal_Path_x64.dll	Windows 64-bit compiled shared library for the "Rx model". This shared library includes the AMI_Init, AMI_GetWave.
Redriver_TMD5_Signal_Path_x64.so	Linux 64-bit compiled shared object library for the "Rx model". This shared library includes the AMI_Init, AMI_GetWave.
Thru.ami	Parameters file for the "tx model" as required by the IBIS-AMI standard. This file is needed to complete the redriver component
Thru_x64.dll	Windows 64-bit compiled shared library for the "TX model". This file is needed to complete the redriver component.
Thru_x64.so	Linux 64-bit compiled shared library for the "TX model". This file is needed to complete the redriver component.
rx_term.s4p	Input termination and package. Captures the input reflection and coupling between input differential pair.
tx_term_NT.s4p	TX driver open termination and package. Use in HDMI1.4 when datarates are <= 1.65Gbps.
tx_term_300.s4p	TX driver 300-Ω differential termination and package. Use in HDMI 1.4 when datarates are > 1.65Gbps
tx_term_100.s4p	TX driver 100-Ω differential termination and package. Use in HDMI 2.0 and 2.1 datarates.
TDP1204_IBIS_AMI_wrk.7zads	ADS archive of a sample test bench for the different modes of operation.

2 Model Parameters

Figure 2-1 shows input and output AMI parameters in Keysight's ADS tool. Note that all reserved parameters should not be adjusted.

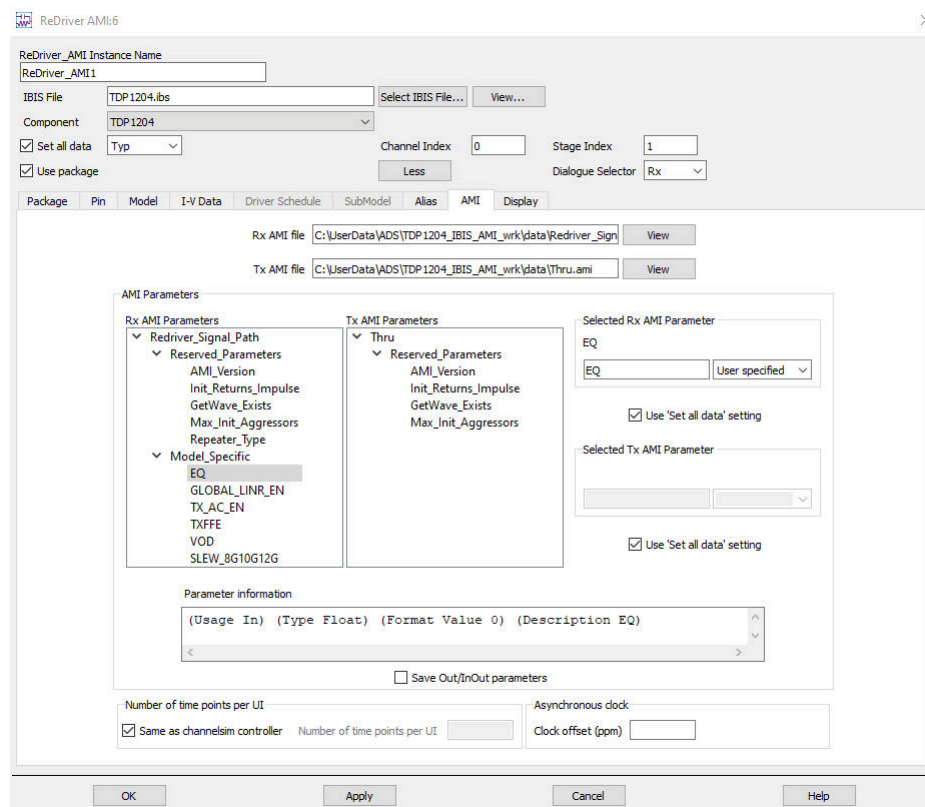


Figure 2-1. Device Specific IBIS-AMI Parameters in ADS Tool

Table 2-1 defines TDP1204 IBIS-AMI model parameters.

Table 2-1. Model Parameters

Model Parameter	Description
GLOBAL_LINR_EN	Global control for selecting between linear and limited redriver. Linear is only supported in FRL model. 1: Linear mode 0: Limited mode (Default)
TX_AC_EN	Controls selection of TX ac-coupled or dc-coupled. Valid only for FRL model. TMDS model is fixed for DC-coupled.TX. 1: AC-coupled 0: DC-coupled (Default)
EQ	EQ control: 0 is lowest and 15 is highest. Default is 0.
TXFFE	TxFFE control when device is in limited mode. Valid only for FRL model. TMDS model does not support de-emphasis. 0: 0dB (Default) 4: -1.5dB 5: -2.5dB 6: -3.5dB 7: -4.8dB
VOD	VOD control when device is in limited mode. In linear mode, the VOD is fixed at 1200mV. 1: Limited at -10% 3: Limited 1000mV (Default) 5: Limited + 10%

Table 2-1. Model Parameters (continued)

Model Parameter	Description
SLEW_8G10G12G	Controls slew rate for 8Gbps, 10Gbps, and 12Gbps FRL datarates when device is configured in limited mode. Valid only for FRL model. 6: Slower edge rate 7: Fastest edge rate (default)
SLEW_3G	HDMI 1.4 Slew rate control: Valid only for TMDS model. 2: slower 3: default slew rate 4: Faster slew rate
SLEW_6G	HDMI 2.0 Slew rate control control: Valid only for TMDS model 3: slower 4: default slew rate 5: faster slew rate
TERM	TX termination control: 0: No termination. Valid for TMDS model only. Use tx_term_NT.s4p with this setting. 1: 300-ohm termination. Valid for TMDS model only. Use tx_term_300.s4p with this setting. 3: 100-ohm termination. Use tx_term_100.s4p with this setting.

3 S-Parameter Models

Table 3-1 describes provided S-parameter models.

Table 3-1. S-Parameter Model Information

Item	Description
RX_term.s4p	A nominal model of TDP1204 package and termination on the receiver pins.
TX_term_NT.s4p	A nominal model of TDP1204 package and termination on the transmitter pins to be used only with the TMDS model. Termination is set to no termination for this model. Use for HDMI1.4 at datarates ≤ 1.65 Gbps
TX_term_300.s4p	A nominal model of TDP1204 package and termination on the transmitter pins to be used only with the TMDS model. Termination is set to 300-ohms for this model. Use for HDMI1.4 at datarates > 1.65 Gbps
TX_term_100.s4p	A nominal model of TDP1204 package and termination on the transmitter pins. Termination is set to 100-ohms for this model. Use for HDMI 2.0 and 2.1.
TUSB1XXX_Cables_halftrace.s4p	Post-channel SDD21 of -2.4dB at 6 GHz
1ft-cable-8in6mil-1ft-cable-1x-thru-1002.s4p	Pre-channel SDD21 of -9.2dB at 6 GHz
HDMI2p1_testcases_csv	CSV file for test cases used in HDMI2.1 simulation

Note

Note that all provided s-parameter models have the port assignments as (1->2, 3->4).

4 Model Verification

The functionality and accuracy of the model is optimized for transmission channels with up to 12 dB of attenuation at the Nyquist frequency. The CTLE function in this model must be set manually using the model parameters defined in Table 2-1.

4.1 Simulation Setup

Figure 4-1 is an example simulation setup. It consists of ideal Tx and Rx models, lossy channels, and the TDP1204 IBIS-AMI model.

The 12 Gbps source is an ideal Tx_Diff model available in ADS's Signal Integrity - Common Components palette. As the model is based on voltage sources, the series resistors are added to mimic the desired source output impedance and establish desired output amplitude.

The TDP1204 model consists of AMI IBIS-AMI model and RX_term and TX_term S-parameter models representing the device package and internal termination. The model parameter may be easily adjusted using the TDP1204 VAR EQN function.

The diagram illustrates an HDMI2p1 signal path simulation. The signal path starts with a Tx driver, followed by a channel model (SnP), a ReDriver_AMI block, another channel model (SnP), and finally an Rx receiver. The signal path is divided into four sections, each with an eye diagram (TTP0, TTP2, TTP3, TTP4_node) and an associated simulation block (ChannelSim, EyeDiff_Probe, EyeProbeSummary, EyeDiff_Probe, EyeProbeSummary, EyeDiff_Probe, EyeProbeSummary, EyeDiff_Probe, EyeProbeSummary).

Signal Path Components:

- Tx:** Tx_Diff, Tx_Diff, BitRate=12 Gbps, Vhigh=Vswing V, Vlow=-Vswing V, RiseFallTime=35 psec, Mode=Bit File, ExcludeLoad=no, EQMode=Specify de-emphasis
- ChannelSim:** ChannelSim, ChannelSim, NumberOfBits=10000, ToleranceMode=Auto, EnforcePassivity=no, Mode=Bit-by-bit
- ReDriver_AMI:** ReDriver_AMI, ReDriver_AMI1, IbisFile="TDP1204.ibs"
- SnP:** SnP, RX_term_pkg, File="rx_term.s4p"
- SnP:** SnP, TX_term_pkg, File="tx_term_100.s4p"
- ChannelSim:** ChannelSim, ChannelSim, NumberOfBits=10000, ToleranceMode=Auto, EnforcePassivity=no, Mode=Bit-by-bit
- Rx:** Rx_Diff, Rx_Diff, Load=100 Ohm

Simulation Settings:

- ChannelSim:** ChannelSim, ChannelSim, NumberOfBits=10000, ToleranceMode=Auto, EnforcePassivity=no, Mode=Bit-by-bit
- BATCH SIMULATION:** BatchSimController, BatchSim, Var=Start=0 Stop=15 Step=1 Lin=, UseSweepPlan=no, Analysis[1]="ChannelSim", UseSweepModule=yes, SweepModule="CSV_List", SweepArgument="HDMI2p1_testcases.csv", UseSeparateProcess=yes, MergeDatasets=yes, RemoveDatasets=yes

Figure 4-1. ADS Simulation Setup

4.2 Simulation Results and Bench Correlation

Figure 4-2 shows simulation results and corresponding bench measurements of the setup described in Figure 4-1.

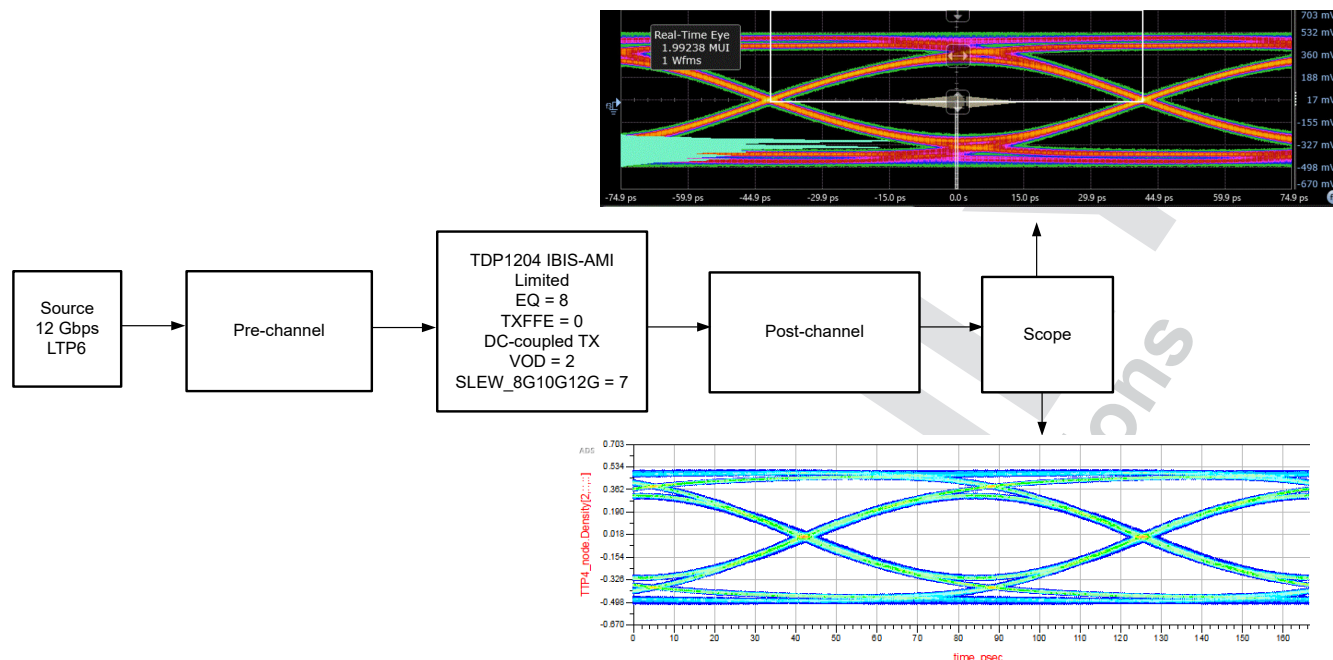


Figure 4-2. Simulation Results and Bench Correlation

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