



# **IBIS-AMI Model QCD Compatibility Report**

Analog Devices rgen0v1\_serdes.ibs

Revision 1.1

Nov 6, 2013

Signal Integrity Software, Inc.  
6 Clock Tower Place, Suite 250  
Maynard, MA 01764  
Phone: (978) 461-0449  
Fax: (978) 461-5092  
[www.sisoft.com](http://www.sisoft.com)

Copyright © 2013 Signal Integrity Software, Inc. All rights reserved. No part of this copyrighted work may be reproduced, modified or distributed in any form or by any means, without the prior written permission of Signal Integrity Software, Inc.

**Right to Copy Documentation**

Signal Integrity Software, Inc. permits licensee to make copies of the documentation for its internal use only. Each copy shall include all copyrights, trademarks, disclaimers and proprietary rights notices.

**Disclaimer**

Signal Integrity Software, Inc. has made reasonable efforts to ensure that the information in this document is accurate and complete. However, Signal Integrity Software, Inc. assumes no liability for errors, or for any incidental, consequential, indirect, or special damages, including, without limitation, loss of use, loss or alteration of data, delays, or lost profits or savings, arising from the use of this document or the product which it accompanies.

**Trademarks**

Quantum Channel Designer, Quantum-SI, SiAuditor, SiSoft and Core-to-Core are trademarks of Signal Integrity Software, Inc. Other product and company names may be trademarks of their respective owners.

**Revisions:**

6 Nov 2013:







- Updated model signatures for AMI file version 1.2 (Change Rx\_R value from 1M to 50 ohms)
- Updated FOM table and simulation screen-shots with results using AMI file version 1.2

## Introduction

This IBIS-AMI Model Report is provided by Signal Integrity Software, Inc. (SiSoft) to indicate compliance with the current IBIS standard and compatibility of submitted IBIS-AMI model files with SiSoft's Quantum Channel Designer (QCD) simulator. Simulation results are included where possible using test conditions designed to exercise basic model behavior and controls.

This report documents the model's certification of operation and accuracy when used with SiSoft's tools. Please contact SiSoft for information about Certification and Correlation services if further validation of this model is desired.

## Scope of Work Performed

-  Compliance with the IBIS 5.1 specification has been examined.
-  Compatibility with QCD Network Characterization has been examined.
-  Compatibility with QCD Statistical and Time-domain simulation has been examined.
-  Compliance of algorithmic models with IBIS Specification requirements has been examined.
-  Certification of models relative to manufacturer specifications has been performed.
-  Correlation of simulation results to reference data has been performed.

## Model(s) Tested and QCD Version

AMI models in the file rgen0v1\_serdes.ibs was analyzed. The model was tested with SiSoft's 2012.08-SP5rc1 software release. Results are scored using the following markers:



The feature works as expected.









The feature may or may not work. Either more information is needed to fully evaluate, or there are special requirements.



There is a problem with either function or IBIS 5.1 compliance.

## Results Summary

Test Performed	TX Result	Comments
QCD Validation		The .ibs and .ami files PASS QCD validation with 0 errors and 0 warnings.
IBIS Parser		The submitted files PASS IBISCHK5 V5.0.7 with 0 errors.
Network Characterization		The analog model is complete and extracts as a reasonable equivalent circuit.
Statistical Simulation		Statistical simulation produces reasonable results across all tests.

Time-Domain Simulation		Time-domain simulation produces reasonable results across all tests.
QCD Compatibility		This model is compatible with QCD 2012.08-SP5rc1

### Results summary

## Model Files

The submitted files are listed below. SiSoft digital signature values have been added to IBIS and AMI files so that they can be verifiably associated with this report.

File	Signature	Notes
rgen0v1_rx.ami	a9f2b8b2ecf160572fbb9d8fafa5989525610a0c	IBIS-AMI parameter file
AnalogDevices_rgen0v1.dll		MS-DOS executable PE for MS Windows (DLL) (GUI) Intel 80386 32-bit
AnalogDevices_rgen0v1_32.dll		MS-DOS executable PE for MS Windows (DLL) (GUI) Intel 80386 64-bit
AnalogDevices_rgen0v1.linux.so		ELF 32-bit LSB shared object, Intel 80386, version 1 (SYSV), dynamically linked, not stripped
AnalogDevices_rgen0v1_32.linux.so		ELF 64-bit LSB shared object, Intel 80386, version 1 (SYSV), dynamically linked, not stripped
rgen0v1_serdes.ibs	491945459cee3913ded566480a9afe7436ba0b44	IBIS part model file

### Model files

## QCD Validation

The submitted files PASS QCD Validation with 0 errors and 0 warnings.

## IBIS 5.1 Parser

The submitted files PASS IBISCHK5 V5.0.7 with 0 errors.

## RX Model Description

The RX model tested is found in the IBIS file **rgen0v1\_serdes.ibs**, revision 1.0 dated 16 May 2013. This model offers the following support:

Platform	Compiler	Bits	Executable	AMI File	Init	Getwave
Linux	gcc4.1.1_32	32	AnalogDevices_rgen0v1.linux.so	rgen0v1_rx.ami	True	True

Linux	gcc4.1.1_64	64	AnalogDevices_rgen0v1_64.linux.so	rgen0v1_rx.ami	True	True
Windows	VisualStudio7.1.3088_32	32	AnalogDevices_rgen0v1.dll	rgen0v1_rx.ami	True	True
Windows	VisualStudio7.1.3088_64	64	AnalogDevices_rgen0v1_64.dll	rgen0v1_rx.ami	True	True

### RX model platform support

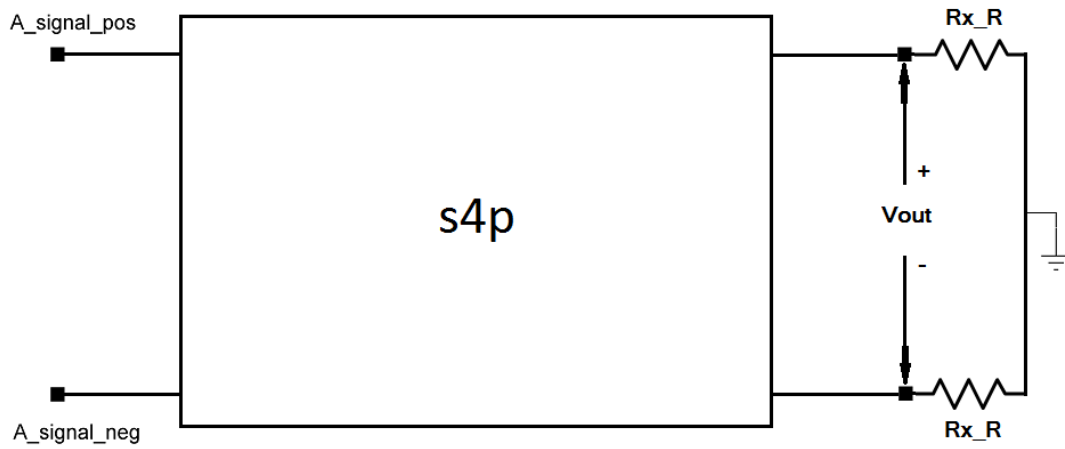
This model processes both impulse responses and waveform data. It supports Statistical simulation through the impulse response returned by AMI\_Init() and Time-Domain simulation through the waveform data returned by AMI\_Getwave(). Because AMI\_Init() must return a LTI response and AMI\_Getwave() can return a nonlinear and time-varying response, the correlation between Statistical and Time-Domain simulation results can vary. SiSoft recommends comparing the two sets of results to determine how well Statistical simulation results approximate their Time-Domain counterparts for your application.

Parameter	Type	Usage	Values	Description
cc	Float	Info	Corner=0.3113e-12, 0.3174e-12, 0.3013e-12	Receiver input capacitance
clock_recovery.count	Integer	In	Default=16; List=8, 16, 32	Early or late count to trigger a phase step
clock_recovery.phase	UI	Out	Range=0.0, 0.0, 1.0	Recovered clock phase
clock_recovery.step	Float	In	Default=0.03125; List=0.0078125, 0.015625, 0.03125, 0.0625, 0.125	Recovered clock phase step.
coupling_config	Integer	In	Default=0; List=0, 1	Internal Coupling: 0=AC 1=DC
eq_config	Integer	In	Default=0; List=0, 1, 2, 3, 4	Linear equalizer setting selection.
rt	Float	Info	Corner=47.15, 48.45, 46.37	Receiver Termination value
rx_clock_recovery_mean	UI	Info	Value=0.039	Recovered Clock offset for statistical analysis
rx_clock_recovery_rj	UI	Info	Value=0.028	Clock jitter for statistical analysis
rx_dcd	UI	Info	Value=0.02	
rx_dj	UI	Info	Value=0.0625	
rx_process	Integer	In	Default=0; Corner=0, -1, 1	Receiver Process Corner: 0=TT - 1=SS 1=FF
rx_r	Float	Info	Value=50	Receiver on-die s-parameter termination resistance.
rx_rj	Float	Info	Value=1e-12	
rx_sj	Float	Info	Value=0.00e-12	
tstonefile	String	Info	rgen0v1_ondie_term_dc_tt_0.s4p, rgen0v1_ondie_term_dc_ss_0.s4p, rgen0v1_ondie_term_dc_ff_0.s4p	Receiver on-die s-parameter files.
vt	Float	Info	Value=0.0	Receiver Termination voltage

### RX model AMI parameters

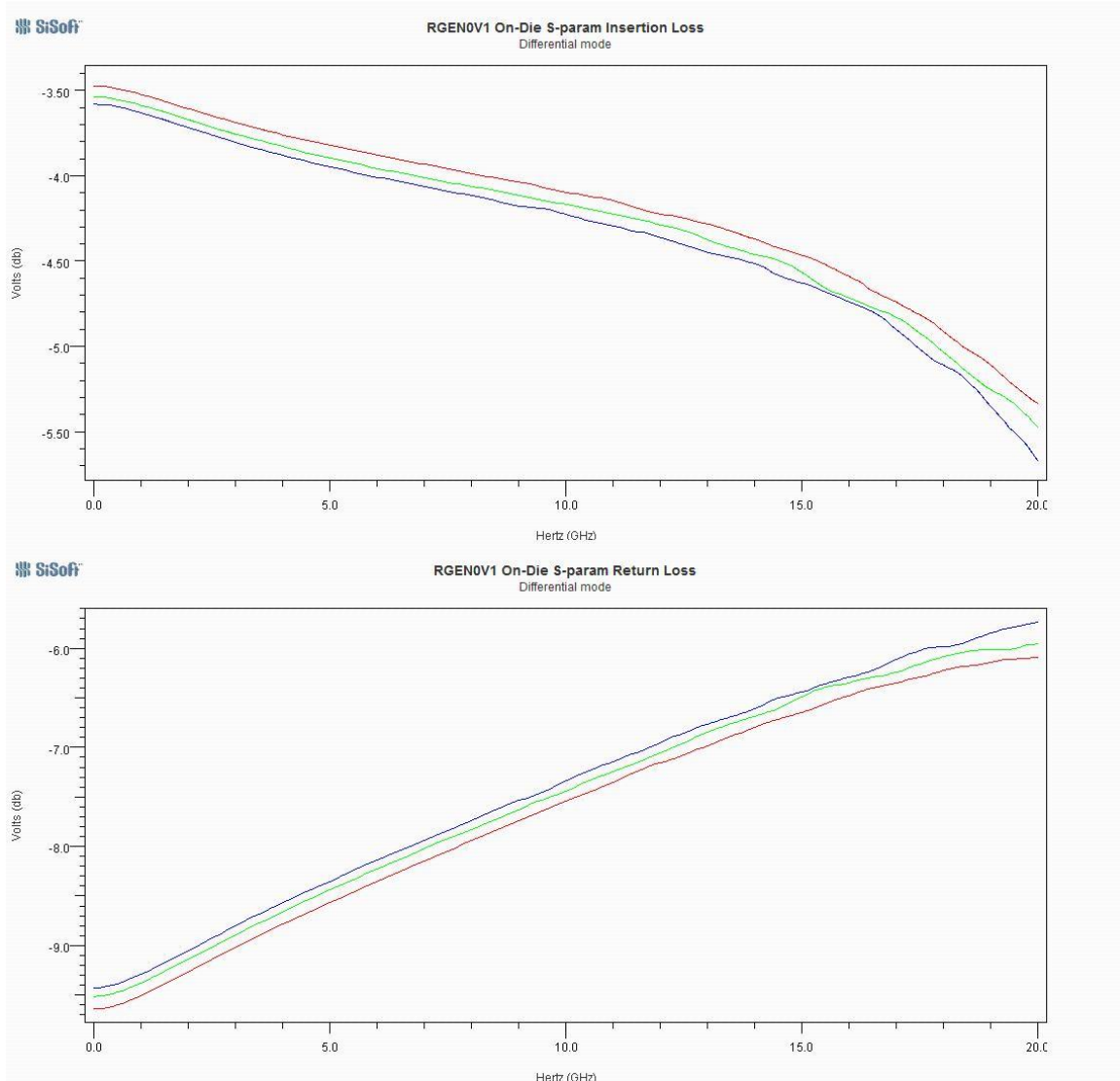
## RX Network Characterization

The RX analog model does comply with the IBIS 5.1 spec. QCD extracts key parameters from the .ibs file to create a linear equivalent circuit, as shown below:



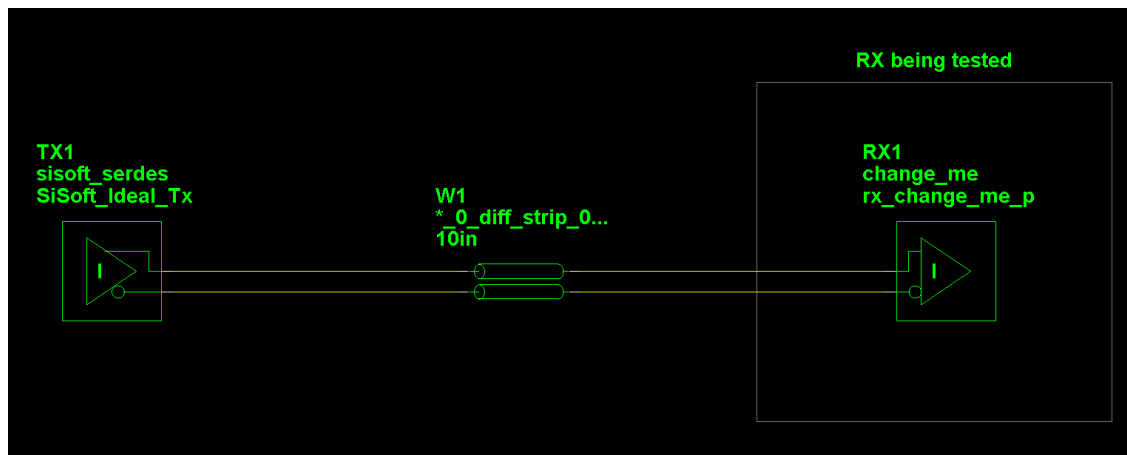
**RX analog model equivalent circuit**

QCD extracted the following values for the analog equivalent circuit. The s-parameter block implements the termination as described in the block diagram of the receiver.



### RX Analog Model S-Parameters

The following network was used to evaluate the behavior of the RX analog model. The SiSoft\_Ideal\_Tx is an ideal transmitter with a 50mV source, 50 ohm output, no output capacitance and zero rise time:

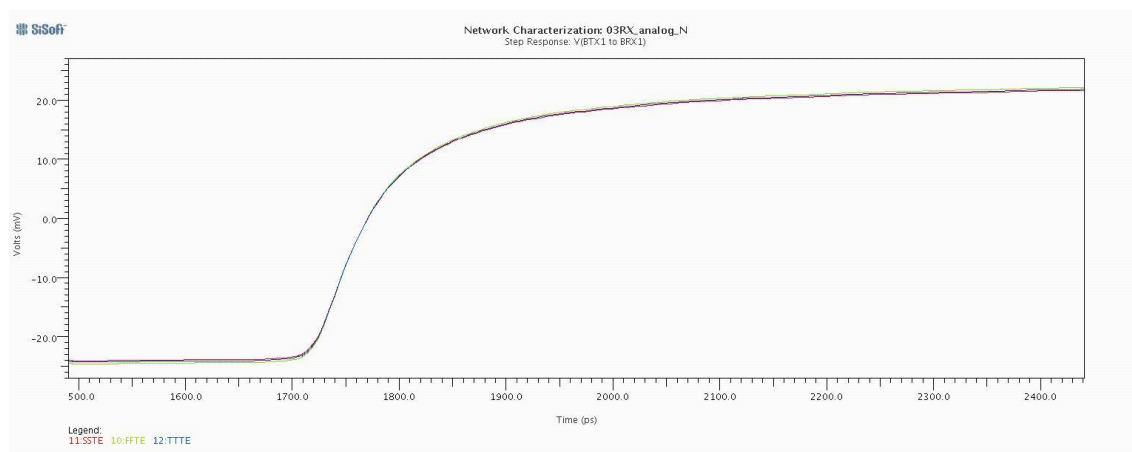


RX test topology

## RX Network Characterization Results

**PASS**

Network characterization yields the following step response:



Network Characterization Step Response: RX, all analog settings

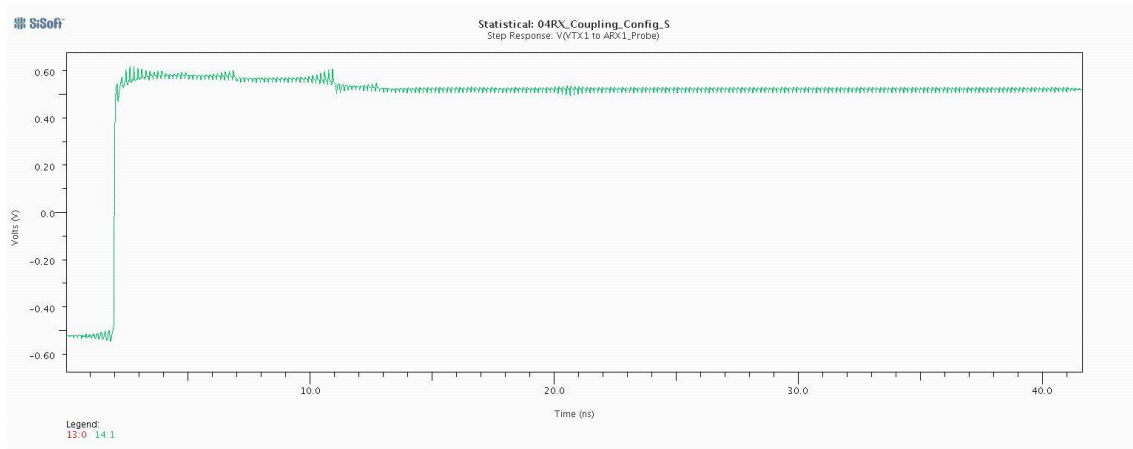
These waveforms appear to be reasonable.

## RX Statistical Simulation Tests

**PASS**

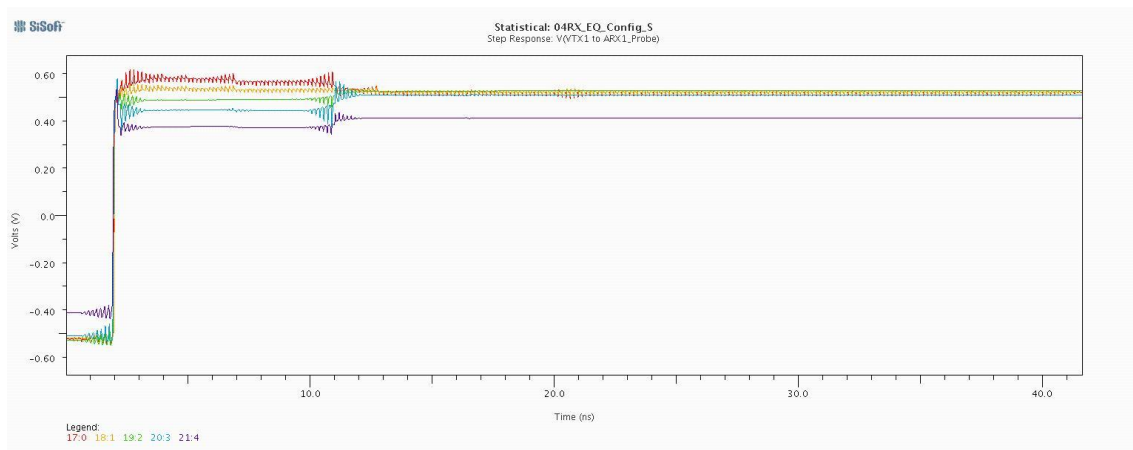
Statistical simulations were run using the test topology at 6.144 Gb/s and 32 samples/bit to test the operation of each of the model's user-settable input controls.





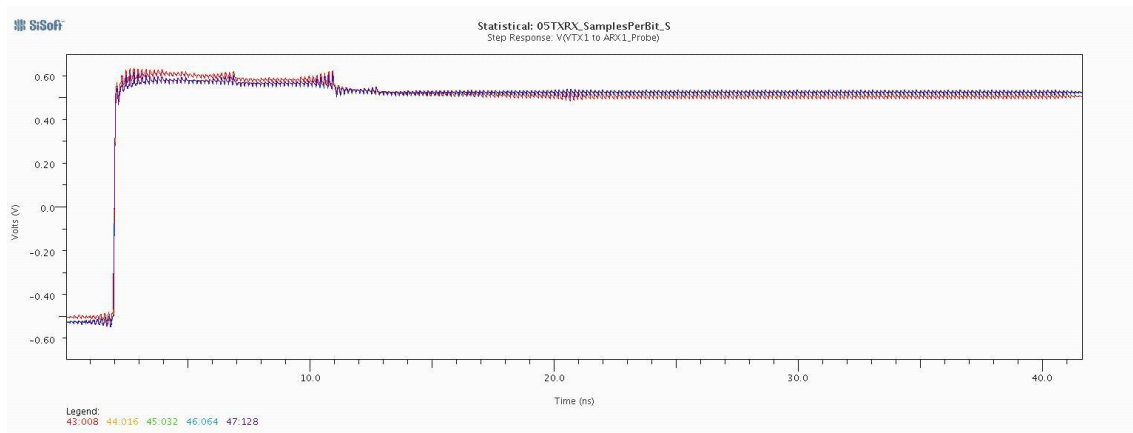
**Statistical Step Response: RX, all Coupling\_Config settings**

As expected, the internal coupling mode has no effect on the response of the model.



**Statistical Step Response: RX, all EQ\_Config settings**

These waveforms appear to be reasonable.

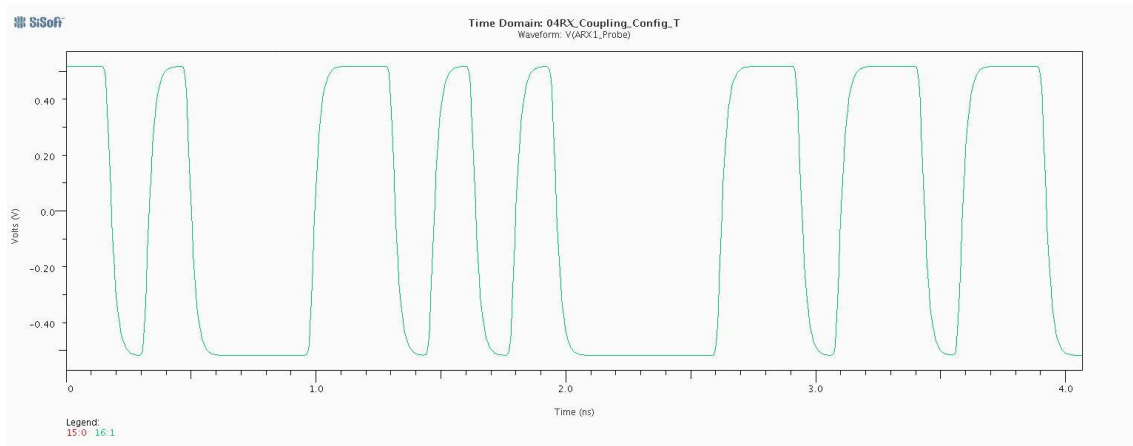


**Statistical Step Response: RX, all SamplesPerBit settings**

# RX Time-Domain Simulation Tests

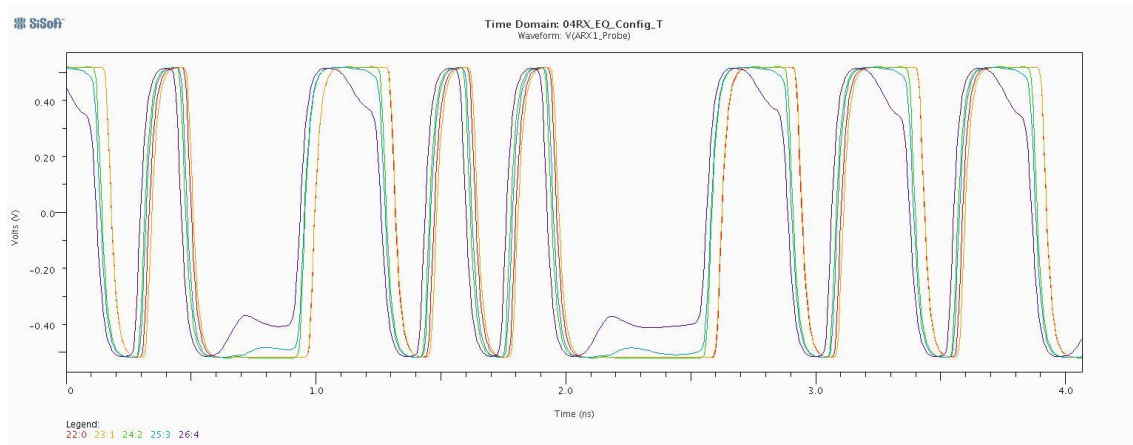
**PASS**

Time-domain simulations were run using the test topology at 6.144 Gb/s to test the operation of each of the model's user-settable input controls. 500019 bits were simulated.



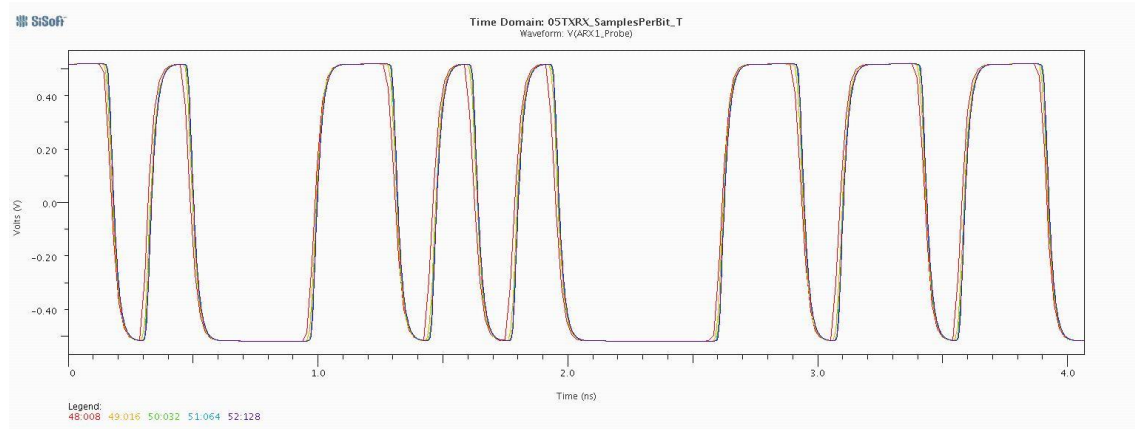
**Time Domain Simulation Waveform: RX, all Coupling\_Config settings**

These waveforms appear to be reasonable.



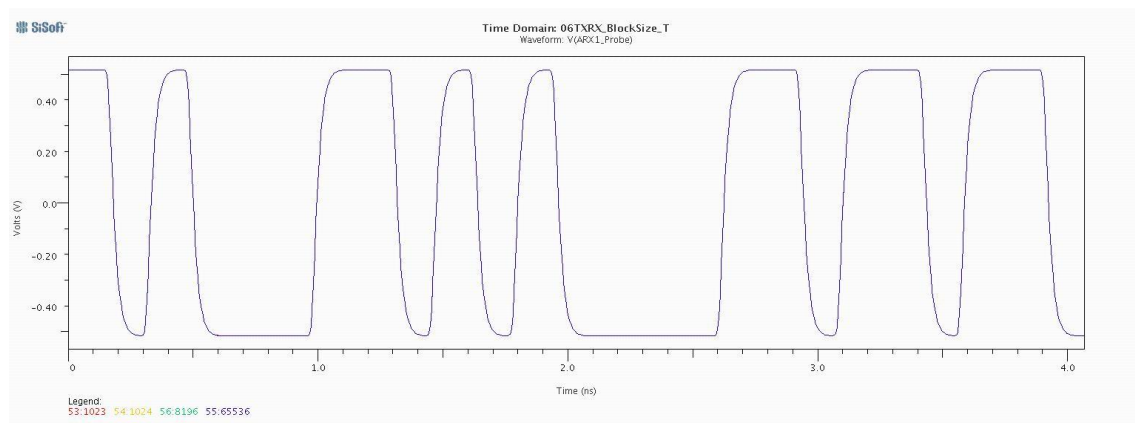
**Time Domain Simulation Waveform: RX, all EQ\_Config settings**

These waveforms appear to be reasonable.



**Time Domain Simulation Waveform: RX, all SamplesPerBit settings**

These waveforms appear to be reasonable.



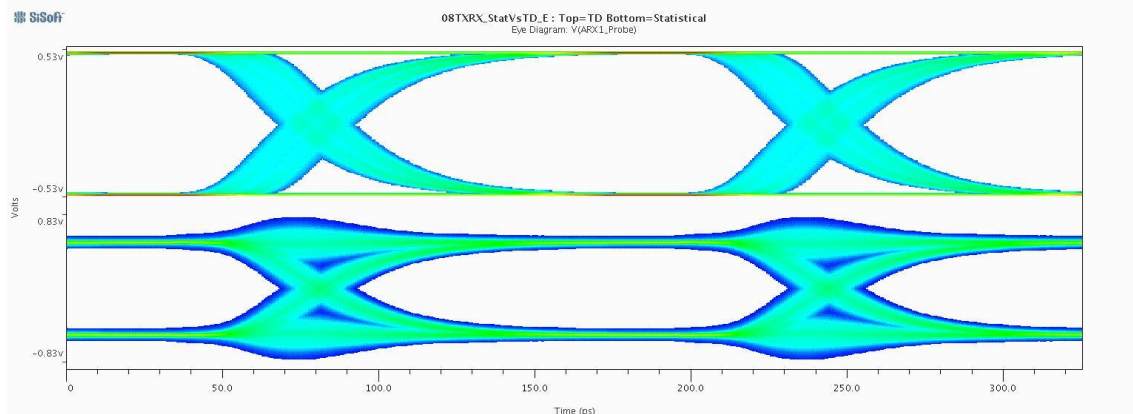
**Time Domain Simulation Waveform: RX, all BlockSize settings**

These waveforms appear to be reasonable.

## RX Statistical and Time-Domain Eye Results



Eye diagrams were derived from both statistical and time domain simulations, for comparison. Both eye diagrams below are taken from RX simulations using base case settings. Ideally the statistical inner eye should be nearly identical to the time domain persistent eye, or at least not larger.



**Eye Diagram: RX, Top=Persistent TD, Bottom=Statistical**

These eye diagrams appear to be reasonable. The statistical eye is at least as optimistic as the time domain persistent eye, and the difference is not excessive.

## **RX Model Compatibility with QCD**

**PASS**

The RX model is compatible with SiSoft's 2012.08-SP5rc1 release.

## **Recommendations**

There is some sensitivity to the number of samples per bit used by the simulator when exercising this model. It is recommended that 16 or more samples per bit be selected in order to achieve the highest accuracy.

## **Next Steps**

This model was tested for QCD certification under SiSoft's Semiconductor Relations Program, which provides testing of AMI models to support mutual customers. SiSoft offers 3 levels of model testing and qualification under this Program:

	Compatible	Certified	Correlated
IBIS Syntax & completeness	•	•	•
Analog model characteristics	•	•	•
Algorithmic model controls	•	•	•
Compliance – Samples/bit	•	•	•
Compliance – Block size	•	•	•
O/S testing – Windows	•	•	•
Compliance – Crosstalk support		•	•
O/S testing – Linux		•	•
Model performance testing		•	•
Design readiness - jitter		•	•
Design readiness – pkg models		•	•
Design readiness – h/w settings		•	•
Optimized for QCD		•	•
QCD Design Kit & documentation		•	•
Interoperability support		•	•
Customized golden reference data			•
Customized metrics & correlation goals			•
Customized topologies & simulation setups			•
Customized Correlation report			•

Compatibility testing does not assess the model's behavior across all possible simulation conditions and does not assess unique setup conditions the model may require in order to produce correct results. AMI Certification tests and documents simulation setups needed to ensure model produce correct results, and documents issues that might affect a model's interoperability with other vendor's models. AMI Model Correlation builds on Correlation activity and establishes the model's correlation to Golden Reference Data. For more information on either of these services, please contact your SiSoft Representative.

Your comments on these documents and services are welcome and appreciated. Please address any comments or questions to [ibis-ami@sisoft.com](mailto:ibis-ami@sisoft.com).

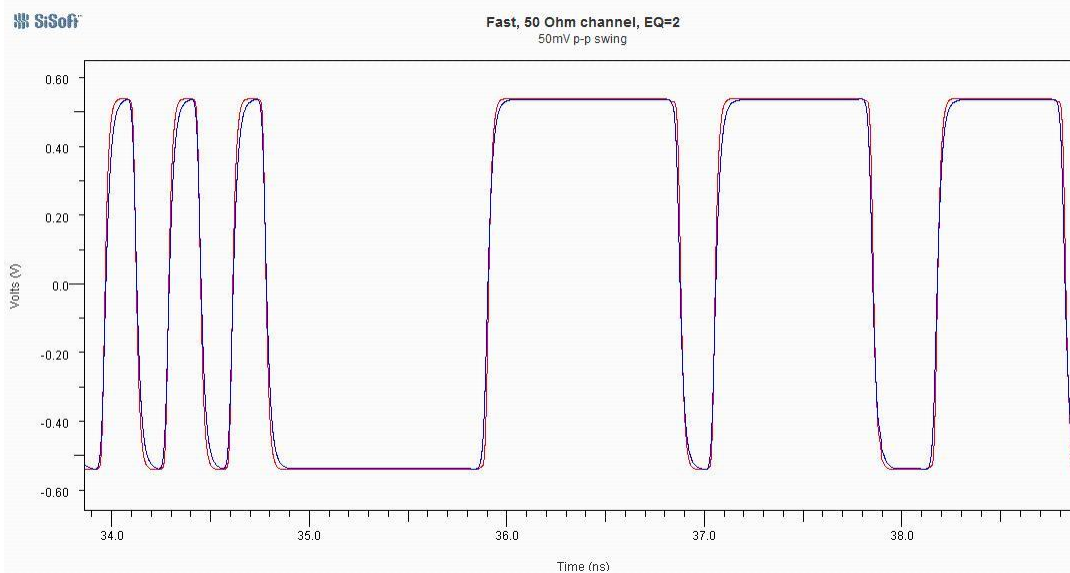
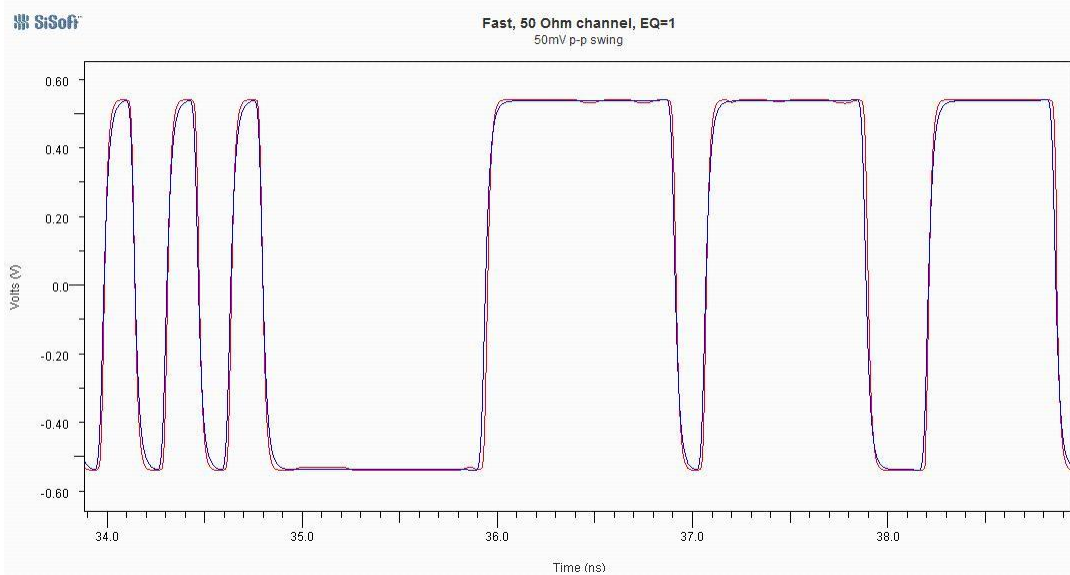
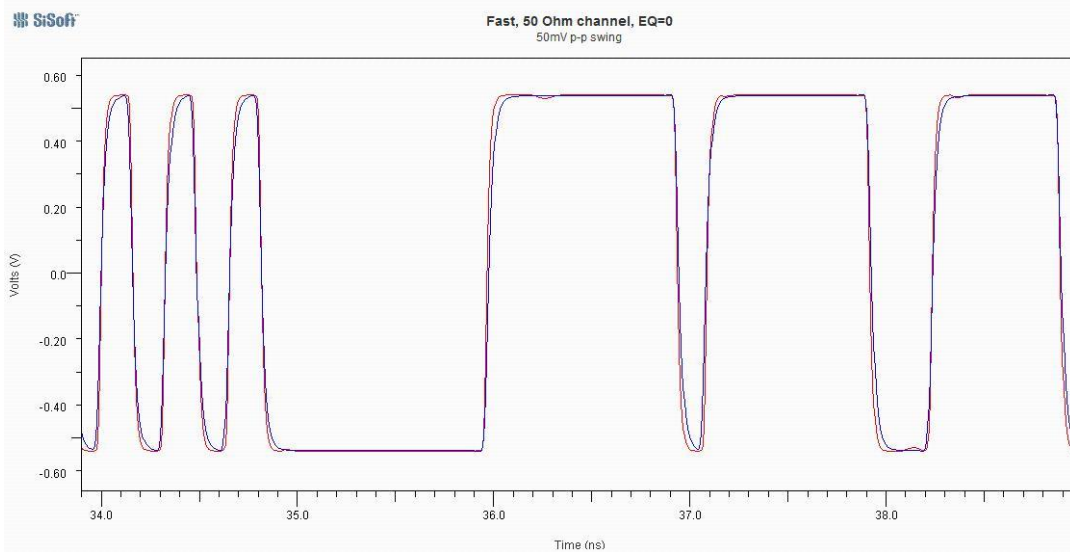
## Correlation Project

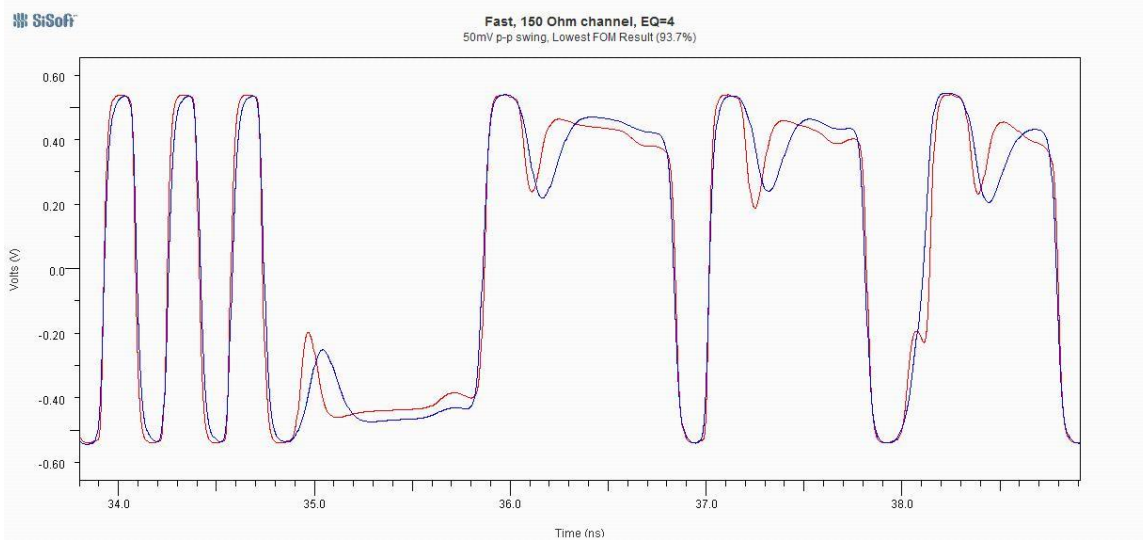
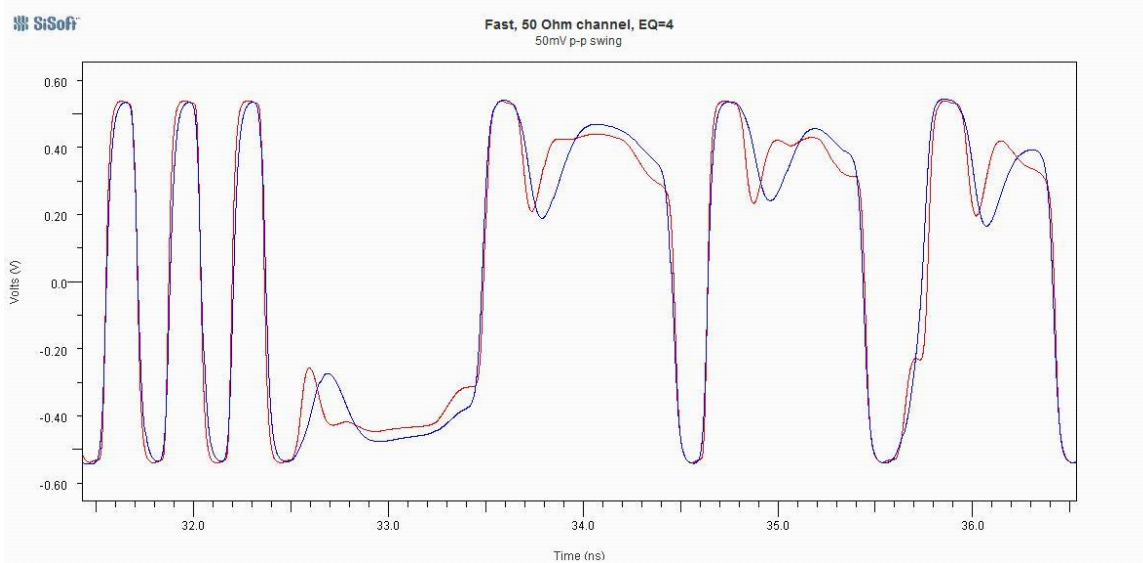
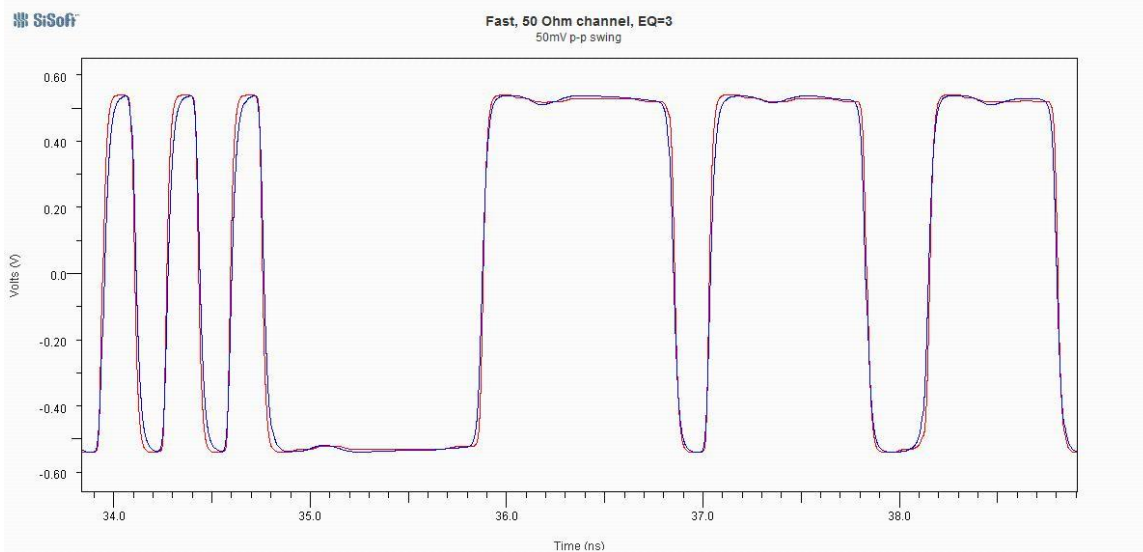
The correlation project performed on the rgen0v1 IBIS AMI model consisted of 135 simulations consisting of an ideal transmitter driving the RX model. Each of the simulations varied the conditions of the model, channel and input swing. The affected parameters were as follows:

Equalization Setting	5 settings	0,1,2,3,4
Corner	3 settings	Slow(-1), Typ(0), Fast(1)
Input Swing	3 settings	50mV, 250mV, 600mV pk-pk
Channel Impedance	3 settings	50, 100, 150 ohms differential
Total Cases	135 cases	

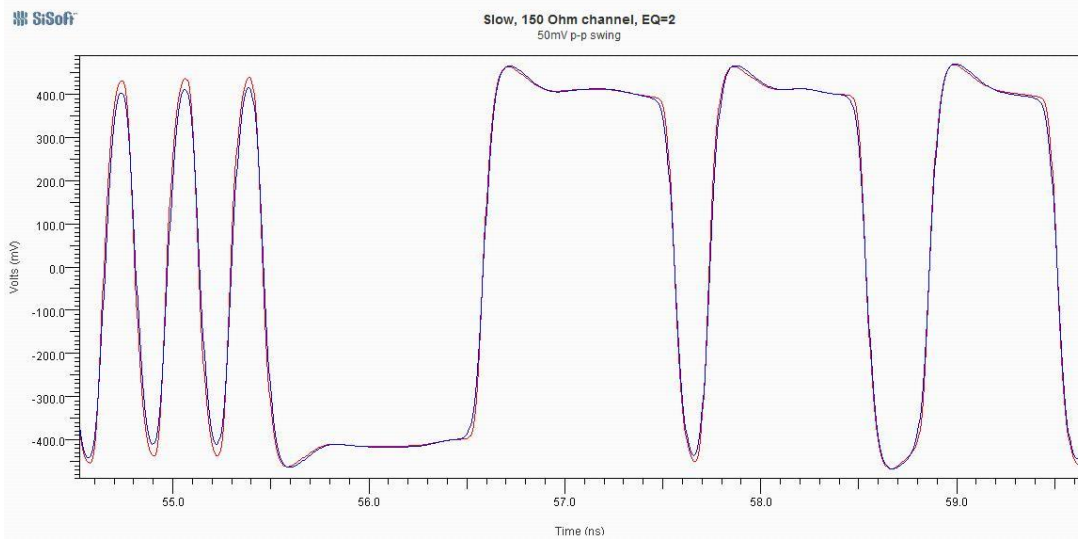
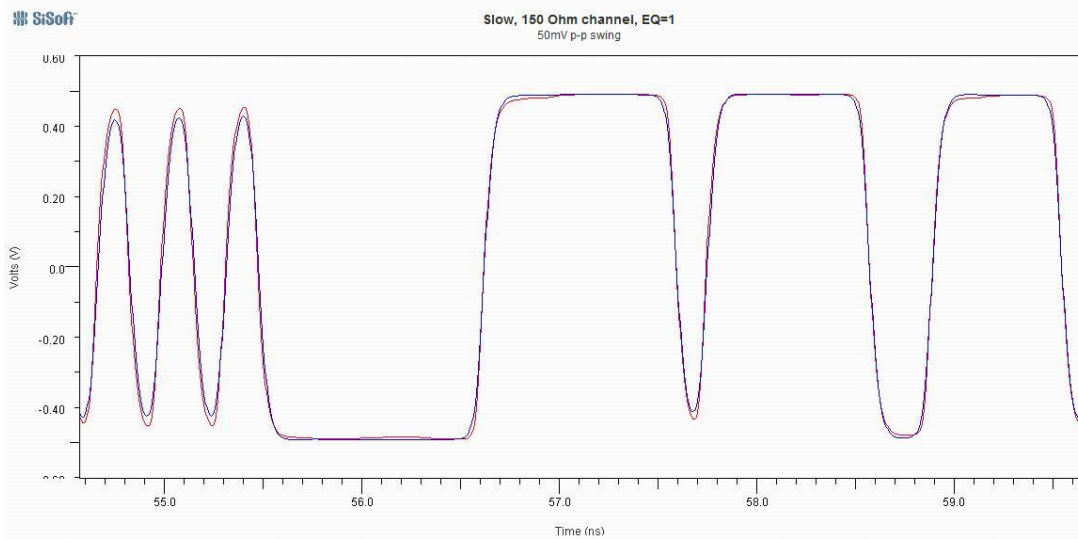
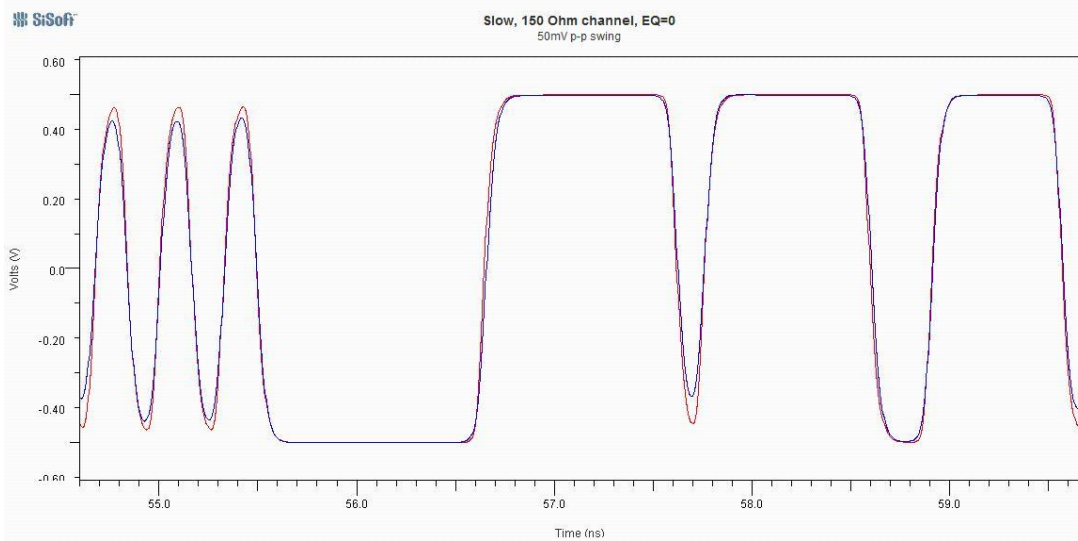
The following 12 screenshots are from the correlation project and are selected as representative cases over the 135 total cases. In each panel, the BLUE trace is the simulation data provided by Analog Devices while the RED trace is the output of the simulation model at the data capture register input point.

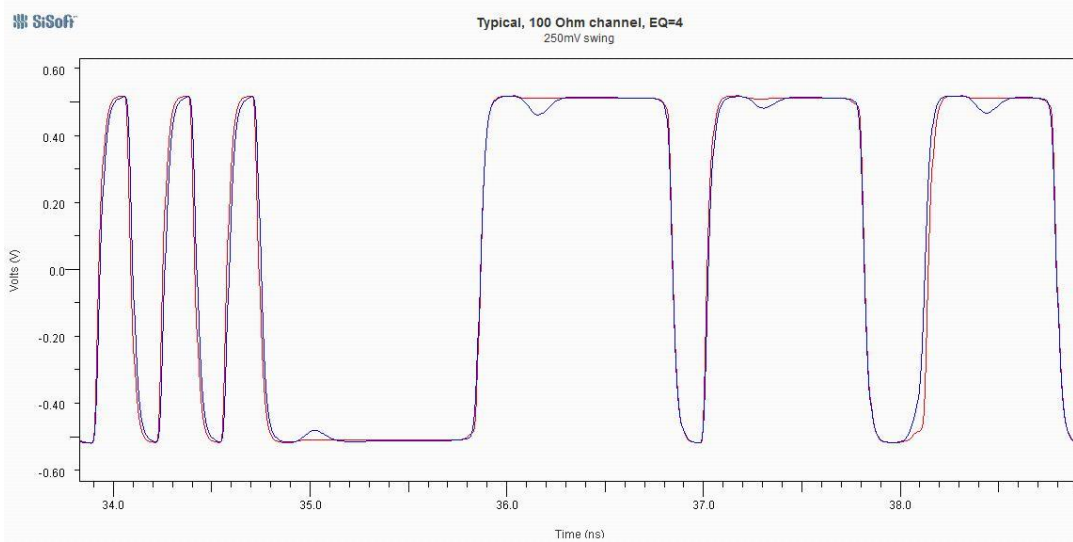
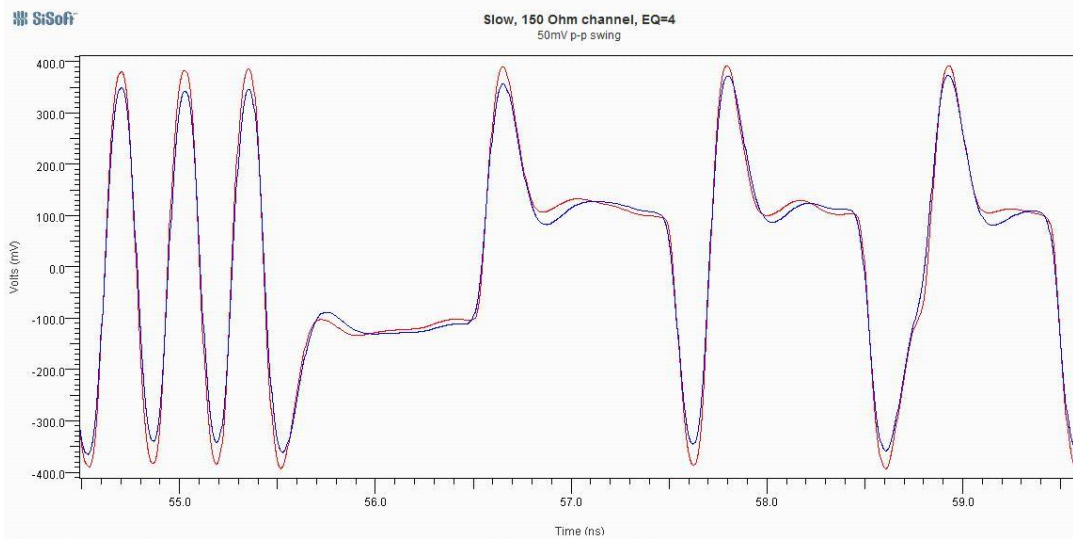
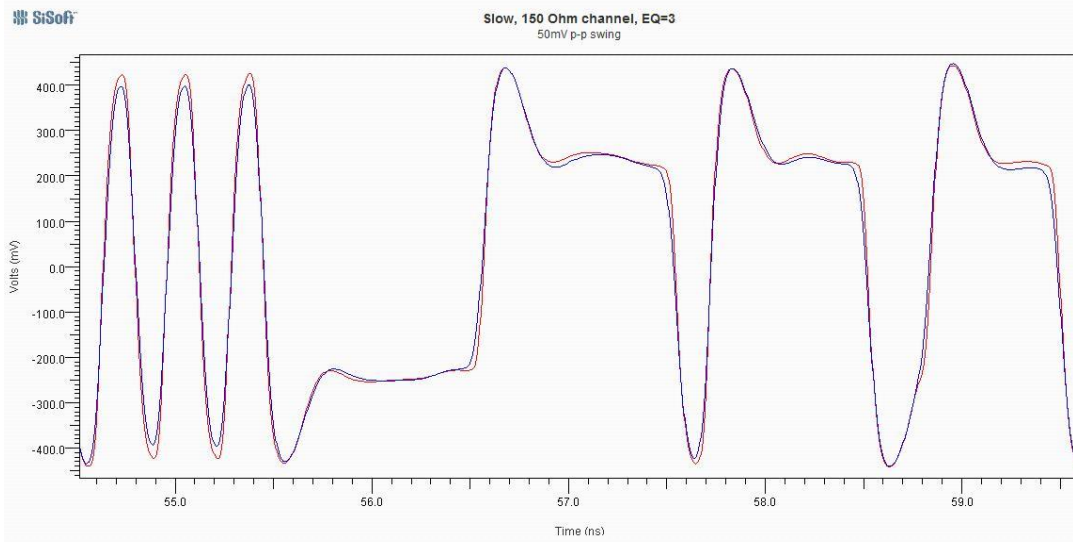
These twelve simulations are representative of the model operation over temperature, voltage and process using three different channel impedances; 50, 100 and 150 ohms differential. All cases used a 50mV pk-pk input signal switching a PRBS7 stimulus. 50mV pk-pk input swing was used for all of these screen shots as it best exhibits the models operation in its linear region. The 250 and 600mV swings saturate the receiver input in pretty much all cases given the channel losses used for the correlation project.











## Correlation Figures of Merit

For each of the 135 correlation simulation cases, a figure of merit (FOM) was calculated by comparison of the ADI supplied simulation and the IBIS AMI model simulation, using the same PRBS7 stimulus. The following table list the FOM for each of the 135 cases. The target FOM for the project is 95% or better.

Equalization	Corner	Input Swing	Channel Impedance	FOM
0	-1	0.05	50	98.5205
0	-1	0.05	100	98.7055
0	-1	0.05	150	98.7856
0	-1	0.25	50	98.9867
0	-1	0.25	100	98.8333
0	-1	0.25	150	98.876
0	-1	0.6	50	98.8531
0	-1	0.6	100	98.8883
0	-1	0.6	150	98.7431
0	0	0.05	50	98.8636
0	0	0.05	100	98.9427
0	0	0.05	150	98.9982
0	0	0.25	50	99.3266
0	0	0.25	100	99.4203
0	0	0.25	150	99.4121
0	0	0.6	50	99.2688
0	0	0.6	100	99.2931
0	0	0.6	150	99.2938
0	1	0.05	50	97.5837
0	1	0.05	100	97.7437
0	1	0.05	150	97.818
0	1	0.25	50	97.9467
0	1	0.25	100	97.9667
0	1	0.25	150	97.948
0	1	0.6	50	98.0076
0	1	0.6	100	98.0144
0	1	0.6	150	98.0017
1	-1	0.05	50	98.1476
1	-1	0.05	100	98.434
1	-1	0.05	150	98.4365
1	-1	0.25	50	98.8763
1	-1	0.25	100	98.8731
1	-1	0.25	150	98.8755

1	-1	0.6	50	98.5339
1	-1	0.6	100	98.7321
1	-1	0.6	150	98.7454
1	0	0.05	50	98.9394
1	0	0.05	100	98.9561
1	0	0.05	150	98.9552
1	0	0.25	50	99.3249
1	0	0.25	100	99.3413
1	0	0.25	150	99.3469
1	0	0.6	50	99.0746
1	0	0.6	100	99.1436
1	0	0.6	150	99.1698
1	1	0.05	50	98.0988
1	1	0.05	100	98.0307
1	1	0.05	150	98.0404
1	1	0.25	50	97.7588
1	1	0.25	100	97.7745
1	1	0.25	150	97.8241
1	1	0.6	50	97.7793
1	1	0.6	100	97.7565
1	1	0.6	150	97.8612
2	-1	0.05	50	98.2943
2	-1	0.05	100	98.5596
2	-1	0.05	150	98.5544
2	-1	0.25	50	98.9901
2	-1	0.25	100	99.0204
2	-1	0.25	150	99.029
2	-1	0.6	50	99.1173
2	-1	0.6	100	99.1113
2	-1	0.6	150	99.1135
2	0	0.05	50	98.0478
2	0	0.05	100	98.2933
2	0	0.05	150	98.2449
2	0	0.25	50	98.8122
2	0	0.25	100	98.8235
2	0	0.25	150	98.8017
2	0	0.6	50	98.9597
2	0	0.6	100	98.9289
2	0	0.6	150	98.9771
2	1	0.05	50	98.0715
2	1	0.05	100	98.0392

2	1	0.05	150	98.028
2	1	0.25	50	98.0329
2	1	0.25	100	98.0576
2	1	0.25	150	98.045
2	1	0.6	50	98.0296
2	1	0.6	100	98.0551
2	1	0.6	150	98.0393
3	-1	0.05	50	97.721
3	-1	0.05	100	98.078
3	-1	0.05	150	98.0267
3	-1	0.25	50	98.1334
3	-1	0.25	100	98.1821
3	-1	0.25	150	98.0947
3	-1	0.6	50	98.5713
3	-1	0.6	100	98.6048
3	-1	0.6	150	98.5858
3	0	0.05	50	98.1646
3	0	0.05	100	98.2183
3	0	0.05	150	98.1791
3	0	0.25	50	98.9678
3	0	0.25	100	98.993
3	0	0.25	150	98.9808
3	0	0.6	50	99.1748
3	0	0.6	100	99.2165
3	0	0.6	150	99.2066
3	1	0.05	50	97.4164
3	1	0.05	100	97.3722
3	1	0.05	150	97.3577
3	1	0.25	50	97.5249
3	1	0.25	100	97.5483
3	1	0.25	150	97.4964
3	1	0.6	50	97.6015
3	1	0.6	100	97.7205
3	1	0.6	150	97.7446
4	-1	0.05	50	97.3998
4	-1	0.05	100	97.4974
4	-1	0.05	150	97.5016
4	-1	0.25	50	96.8287
4	-1	0.25	100	96.8354
4	-1	0.25	150	96.7253
4	-1	0.6	50	97.7399

4	-1	0.6	100	97.6531
4	-1	0.6	150	97.6928
4	0	0.05	50	97.0582
4	0	0.05	100	97.0638
4	0	0.05	150	97.0092
4	0	0.25	50	96.6697
4	0	0.25	100	96.7194
4	0	0.25	150	96.6452
4	0	0.6	50	97.272
4	0	0.6	100	97.3036
4	0	0.6	150	97.1855
4	1	0.05	50	94.0044
4	1	0.05	100	94.0464
4	1	0.05	150	93.6983
4	1	0.25	50	95.3934
4	1	0.25	100	95.4669
4	1	0.25	150	95.3393
4	1	0.6	50	95.939
4	1	0.6	100	95.7912
4	1	0.6	150	95.9109