Application Note
Document version: 4 — December 2013

Quick Start Guide
Example DS1xxDF410 Agilent ADS Project

Version 3
December 2013

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1 Document Revision History

Revision	Editor	Comment	Date
1	Casey Morrison [cmorrison@ti.com]	Initial creation of Quick Start Guide for example ADS project.	30-Nov-2012
2	Casey Morrison [cmorrison@ti.com]	Updated example project after model update.	28-Feb-2013
3	Casey Morrison [cmorrison@ti.com]	Updated example project after model update.	30-Sept-2013
4	Casey Morrison [cmorrison@ti.com]	Added note that 100 Ohm termination resistor must be kept in schematic due to how ADS interprets the IBIS file.	16-Dec-2013

2 Overview

This document is a Quick Start Guide for a custom Agilent ADC project using the DS1xxDF410 Advanced Retimer in a generic channel topology. Table 1 below lists pertinent information related to the delivered project.

Table 1: Quick Start Guide related information

Item	Value/Comment
IBIS-AMI Simulator	*Agilent ADS*
IBIS-AMI Simulator version	*2013.06*. TI strongly recommends updating to version 2013.06 or later to enable certain features such as single-schematic repeater/retimer simulations.
TI device models included	*DS1xxDF410 Advanced Retimers:* DS100DF410, DS110DF410, DS125DF410
Other device models included	*None*. When interfacing to the DS1xxDF410, only generic TX/RX models were used. Customer will need to replace these with other vendors' models if desired.
Project names	*Agilent_ADS_2013.06.7zads*: ADS project using the DS1xxDF410 Advanced Retimer.
Supported platforms	• 32-bit Windows • 64-bit Windows • 64-bit Linux

The topology implemented in the three example projects matches Figure 1 below. There are two main parts to this topology:

1. Link between a generic TX model and the DS1xxDF410 Retimer.
2. Link between the DS1xxDF410 Retimer and a generic RX model.

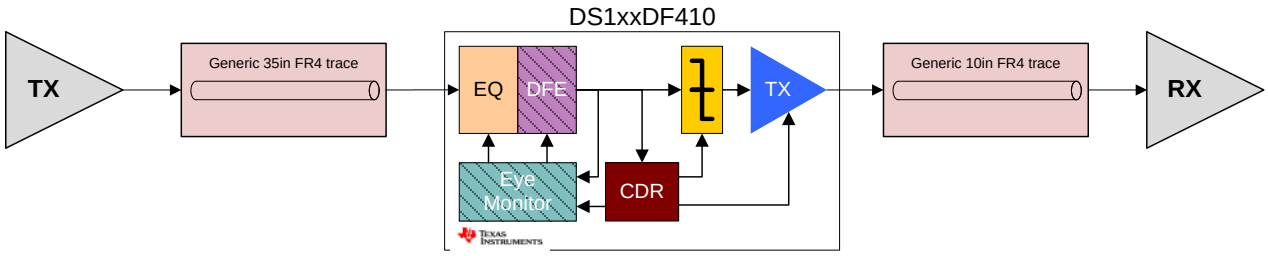


Figure 1: Link topology for the DS1xxDF410 example project

3 Project Quick Start Guide

The DS1xxDF410 example project included in this distribution contains two schematics, as shown in Figure 2:

- ***ASIC_TX_to_DS1xxDF410***: Link between Generic ASIC TX model and the DS1xxDF410 Advanced Retimer. Contains a generic TX model *which should be replaced by the ASIC vendor's TX model*, a generic FR4 trace model *which should be replaced by actual channel*, and the DS1xxDF410 RX model.

- ***DS1xxDF410_to_ASIC_RX***: Link between the DS1xxDF410 Advanced Retimer and generic receiver through a PCB board trace. Contains the DS1xxDF410 TX model, a generic FR4 trace model *which should be replaced by the actual channel*, and a generic RX model *which should be replaced by the ASIC vendor's RX model*.

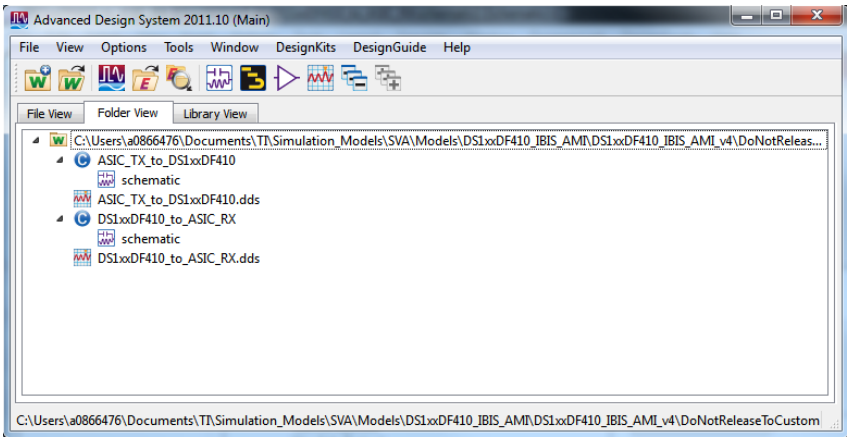


Figure 2: ADS main window showing the available schematics

Between these two schematics the full link described in Figure 1 can be simulated and analyzed. The recommended procedure for simulating the enclosed example project is as follows:

1. Open the project. From the main ADS control window, select "File > Unarchive Workspace or Project", then browse to the project file provided with this release: Agilent_ADS_2013.06.7zads. ADS will ask you to name the project and specify where you want it to be placed.

2. Open the ASIC_TX_to_DS1xxDF410 schematic and replace the generic TX IBIS-AMI model with the desired ASIC vendor TX model. This can be done by double-clicking on the TX_AMI model. Browse to and select the desired IBIS model to replace the generic TX model that is currently instantiated in the schematic. Note that this generic TX model does not contain any de-emphasis or amplitude control and is solely for the purpose of completing the simulation setup.

3. Replace the generic TX package model with the package model supplied by the ASIC TX vendor. Do this by double-clicking on the TX package s-parameter block and selecting the new s-parameter file. Note that the example ASIC TX package used in this schematic has a port ordering such that port 1 goes to port 3 and port 2 goes to port 4. If the package model supplied by the ASIC TX vendor has a different port ordering, then the schematic hook-up will need to be edited to make sure the signal propagates through the package and into the channel correctly.

4. Replace the generic FR4 trace model with your system's channel.

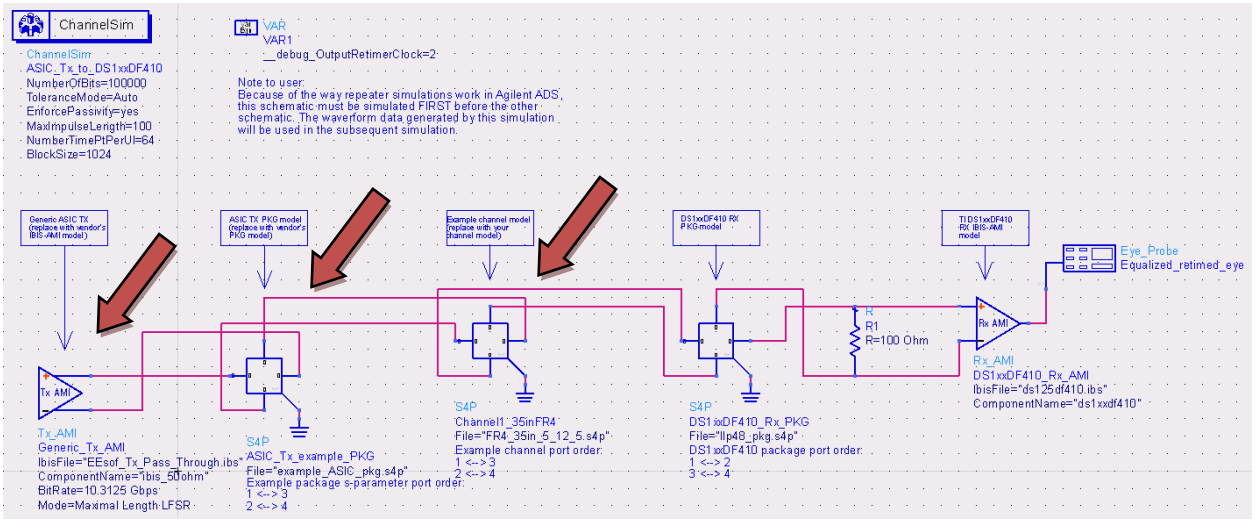


Figure 3: ASIC TX to DS1xxDF410 schematic (user should replace the items with arrows pointing to them)

Note: The Rx termination in the DS1xxDF410 IBIS-AMI model is modeled using [Series Pin Mapping] and [R series] within the .ibs file. However, Agilent ADS Rx_AMI does not look at the [Series Pin Mapping] and any series models between the differential pins. So the 100 Ohm differential termination needs to be added separately in the schematic, as shown in Figure 3.

If the model is of the type [Terminator], ADS supports common mode terminations to ground and power supply (similar to the ideal pass-through Rx model in ADS). However, this does not allow us to specify a proper differential termination. We observed that the results are not same with common-mode and differential terminations for many cases. Also, Terminator model types are not supported with other tools. Therefore, the differential termination resistor should be kept in the schematic.

5. Simulate the ASIC_TX_to_DS1xxDF410 schematic by clicking on the  button. As the schematic is simulating ADS will display the simulation progress. Before simulating you can adjust the DS1xxDF410's receiver settings by double-clicking on the DS1xxDF410 model and going to the AMI parameters tab. For more information on the model-specific parameters, refer to the model user's guide (TI_DS1xxDF410_AMI_model_User_Guide.pdf).

6. Once the simulation completes, the plot window will appear. To plot the resulting post-equalized eye, click on the  button and click again in the blank area to drop down a plot axis.

7. When the plot is inserted, the “Plot Traces & Attributes” window will open up. Select “Density” and then clock on “>>Add>>”. Click “OK” to plot the eye.

8. The eye plot will appear in the plot window, as shown in Figure 4. Note that this is a plot of the eye as it appears after the DS1xxDF410’s CTLE and DFE equalization but before the retiming function, TX de-emphasis, and VOD are applied. This plot will be equivalent to the input to the decision slicer. It is also possible to simulate and plot the output of the decision slicer (by setting RX_Config=0), however doing this will not give you visibility into the receiver’s eye opening margin.

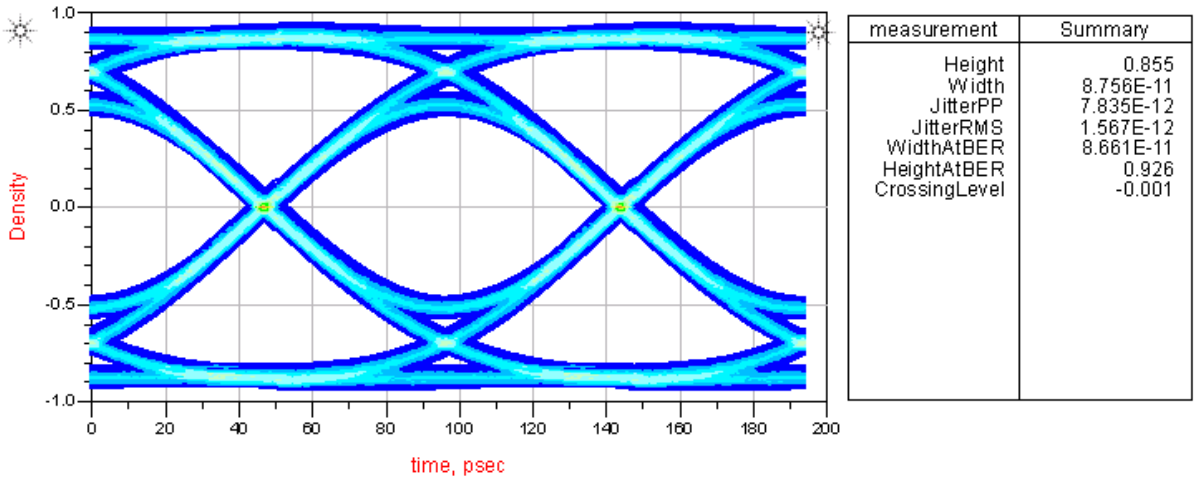


Figure 4: Eye plot for ASIC TX to DS1xxDF410 RX link with RX_Config=2

9. Once the ASIC TX to DS1xxDF410 link has been simulated you can then open the DS1xxDF410_to_ASIC_RX schematic and replace the generic RX IBIS-AMI model with the desired ASIC vendor RX model. This can be done by double-clicking on the RX_AMI model. Browse to and select the desired IBIS model to replace the generic RX model that is currently instantiated in the schematic. *Note that this generic RX model included in this project does not contain any equalization.*

10. Replace the generic RX package model with the package model supplied by the ASIC RX vendor. Do this by double-clicking on the RX package s-parameter block and selecting the new s-parameter file. Note that the example ASIC RX package used in this schematic has a port ordering such that port 1 goes to port 3 and port 2 goes to port 4. If the package model supplied by the ASIC RX vendor has a different port ordering, then the schematic hook-up will need to be edited to make sure the signal propagates through the package and into the channel correctly.

11. Replace the generic FR4 trace model with your system's channel.

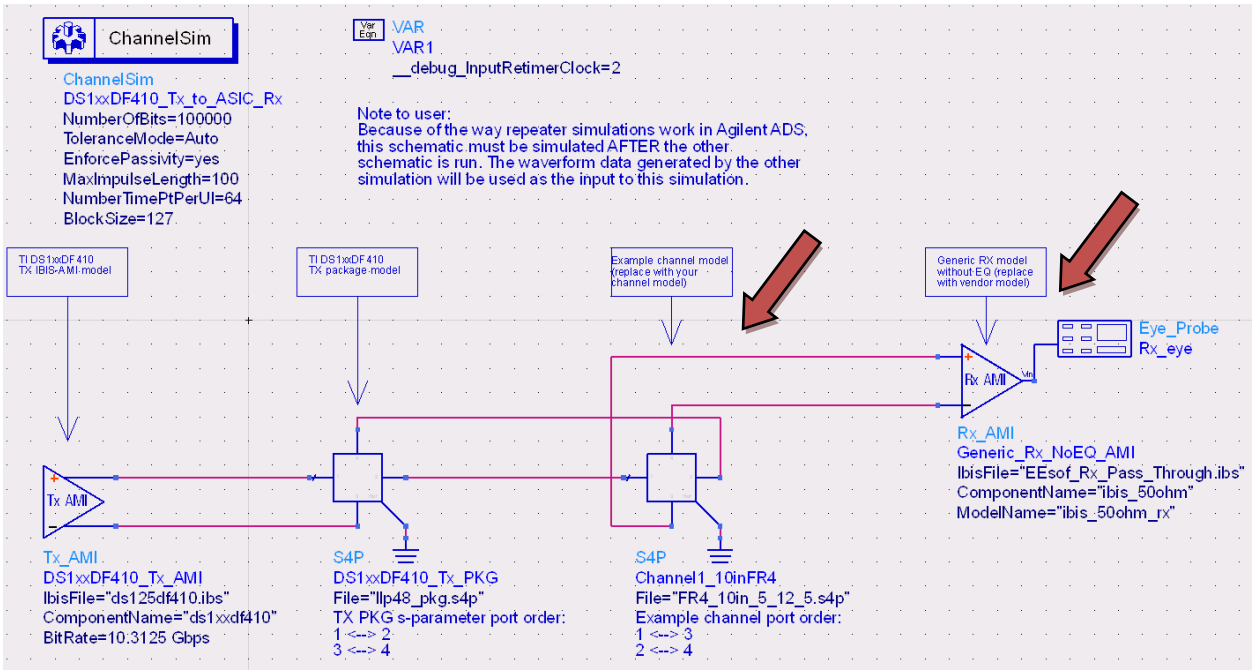


Figure 5: DS1xxDF410 to ASIC RX schematic

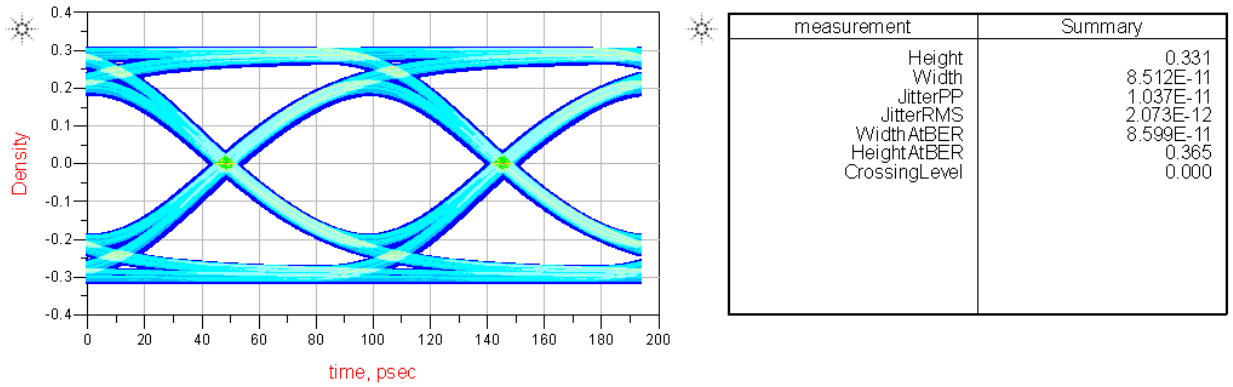
12. Once the simulation completes, plot the eye (a.k.a. Density) and the mask. Figure 6 shows an example eye plot at the output of the channel. The quality of the eye generated in this second simulation will be affected by:

    a. The DS1xxDF410 output drive level (VOD_Level)

    b. The DS1xxDF410 de-emphasis level (DE_Level)

    c. The RX model's equalization settings (if there are any)

    The DS1xxDF410's TX parameters are controllable via the model-specific AMI parameters DE, DE_range, and VOD. Refer to the model user's guide (TI_DS1xxDF410_AMI_model_User_Guide.pdf) for details on these parameters. The model-specific parameters are accessible by double-clicking on the TX_AMI model and selecting the AMI tab, as shown in Figure 7.



measurement	Summary
Height	0.331
Width	8.512E-11
JitterPP	1.037E-11
JitterRMS	2.073E-12
WidthAtBER	8.599E-11
HeightAtBER	0.365
CrossingLevel	0.000

Figure 6: Example eye plot for ASIC TX to DS1xxDF410 to Optical module

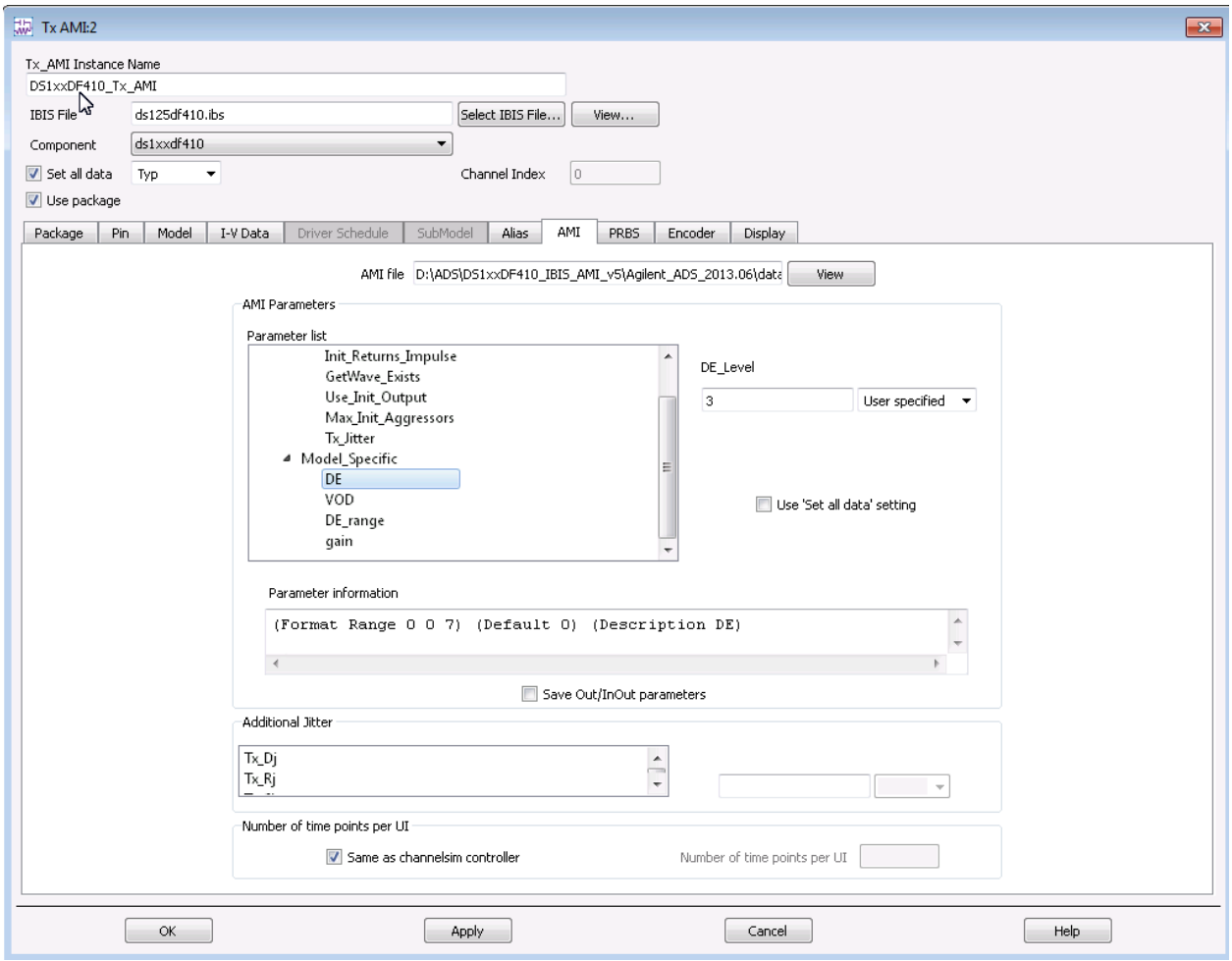


Figure 7: Edit the DS1xxDF410 TX parameters if desired

4 Suggestions and Tips

Simulations involving a configurable transmitter model and a configurable receiver model (especially if they originate from different IC vendors) often involve running multiple iterations in an attempt to identify the best settings. Here are some general tips for optimizing your simulations:

- ASIC TX to DS1xxDF410 Retimer direction
    - The DS1xxDF410 will equalize and retime the data transmitted by the ASIC TX. Because of this, it is not necessary to spend numerous simulation cycles optimizing the eye at the Retimer input. As long as the eye is open “enough” to recover the data, then the data stream will be retimed and re-transmitted at the Retimer output.
    - Generally speaking, an amplitude setting of 0.8V to 1.2V, and a de-emphasis setting of 0dB to -3dB on the ASIC TX should be adequate for most channels.
    - Time is better spent optimizing theDS1xxDF410 to ASIC / optical module direction.
- Retimer to ASIC RX / Optical module direction
    - The following model-specific parameters will affect the eye shape: DS1xxDF410 VOD_Level and DE_Level.
    - For SFF-8431 you can start by applying VOD=4 (1.0Vppd), DE=2, and DE_range=0 (-3.5dB). From here, adjust the DE and DE_range parameters until the eye opening is maximized. If necessary, increase or decrease the VOD to meet the SFF-8431 eye mask. The optimum VOD, DE, and DE_range will depend on the channel between the DS1xxDF410 and the optical module.
- General debug
    - The adaption of the CTLE and DFE is logged in a file which the model generates called Adapt.txt.
    - If this file exists already (typically in the ‘data’ directory for Agilent ADS), then results will be appended to the end of this file. If the file doesn’t exist, then the model will create it.
    - This file will show how the CTLE and DFE adapt to maximize the horizontal and vertical eye opening (HEO and VEO). The CTLE range is printed as 1 to 32 and these values correspond to EQ levels of 0 to 31.