User's Guide
DS125MB203 IBIS-AMI Model

Version 2
April 2024

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1 Document Revision History

Revision	Editor	Comment	Date
1	Casey Morrison	Initial creation of User's Guide.	10-Nov-2012
2	Lucas Wolter	Updated for public release.	23-April-2024

2 Overview

This document is a User’s Guide for the DS125MB203 Buffer Repeater. Table 1 below lists pertinent information related to the delivered model.

Table 1: Model information

<table>
<tr><th>Item</th><th>Value/Comment</th></tr>
<tr><td>TI device models included</td><td>DS125MB203 Buffer Repeater (device datasheet)</td></tr>
<tr><td>IBIS version</td><td>Compliant to IBIS version 5.1.
Note: The concept of a “repeater” in the context of IBIS-AMI had not been standardized at the time this document was written. However, several EDA vendors have anticipated the standardization of repeater models and included this feature in their tools (Agilent ADS and SiSoft QCD to name a few).</td></tr>
<tr><td>Supported platforms</td><td>• 32-bit Windows
• 64-bit Windows
• 64-bit Linux</td></tr>
<tr><td>Release package files</td><td>TI_DS125MB203_IBIS_AMI_v2
|
+-- Example_Projects
| |
| +-- TI_DS125MB203_ADS_Project_Quick_Guide.pdf
| +-- Agilent_ADS_2011.10.7zap
|
+-- Model
      |
      +-- TI_DS125MB203_IBIS_AMI_User_Guide.pdf
      +-- DS125MB203_ramp.ibs
      +-- DS125MBxxx_Tx_11_2012.ami
      +-- DS125MBxxx_Rx_11_2012.ami
      +-- DS125MBxxx_Tx_11_2012.dll
      +-- DS125MBxxx_Rx_11_2012.dll
      +-- DS125MBxxx_Tx_11_2012_x64.dll
      +-- DS125MBxxx_Rx_11_2012_x64.dll
      +-- DS125MBxxx_Tx_11_2012_x64.s0
      +-- DS125MBxxx_Rx_11_2012_x64.so
      +-- repeater_pkg.s4p</td></tr>
</table>

3 Receiver Model Parameters

The DS125MB203 receiver model includes the following model-specific parameters:

1. **EQ_Level**: This parameter sets the Repeater’s input equalization setting. Refer to Table 2 of the device datasheet (copied below for convenience).

Table 2: Equalizer Settings

Model EQ_Level setting	Level	EQA1 EQB1	EQA0 EQB	EQ – 8 bits [7:0]	dB at 1.5 GHz	dB at 2.5 GHz	dB at 4 GHz	dB at 6 GHz	Suggested Use
0	1	0	0	0000 0000 = 0x00	2.5	3.5	3.8	3.1	FR4 < 5 inch trace
1	2	0	R	0000 0001 = 0x01	3.8	5.4	6.7	6.7	FR4 5-10 inch trace
2	3	0	Float	0000 0010 = 0x02	5.0	7.0	8.4	8.4	FR4 10 inch trace
3	4	0	1	0000 0011 = 0x03	5.9	8.0	9.3	9.1	FR4 15-20 inch trace
4	5	R	0	0000 0111 = 0x07	7.4	10.3	12.8	13.7	FR4 20-30 inch trace
5	6	R	R	0001 0101 = 0x15	6.9	10.2	13.9	16.2	FR4 25-30 inch trace
6	7	R	Float	0000 1011 = 0x0B	9.0	12.4	15.3	15.9	FR4 25-30 inch trace
7	8	R	1	0000 1111 = 0x0F	10.2	13.8	16.7	17.0	8m, 30awg cable
8	9	Float	0	0101 0101 = 0x55	8.5	12.6	17.5	20.7	> 8m cable
9	10	Float	R	0001 1111 = 0x1F	11.7	16.2	20.3	21.8	
10	11	Float	Float	0010 1111 = 0x2F	13.2	18.3	22.8	23.6	
11	12	Float	1	0011 1111 = 0x3F	14.4	19.8	24.2	24.7	
12	13	1	0	1010 1010 = 0xAA	14.4	20.5	26.4	28.0	
13	14	1	R	0111 1111 = 0x7F	16.0	22.2	27.8	29.2	
14	15	1	Float	1011 1111 = 0xBF	17.6	24.4	30.2	30.9	
15	16	1	1	1111 1111 = 0xFF	18.7	25.8	31.6	31.9	

Note: Cable and FR4 lengths are for reference only. FR4 lengths based on a 100 Ohm differential stripline with 5-mil traces and 8-mil trace separation. Optimal EQ setting should be determined via simulation and prototype verification.

2. **Limit**: This parameter puts the device into a limiting or non-limiting mode.

Model Limit setting	Description
0	In this mode the model operates in non-limiting mode. The peakto-peak output voltage depends on the peak-to-peak input voltage. *This mode is required for applications which require link training (i.e. 8Gbps PCIe-Gen3, 10.3125Gbps 10GBASE-KR, and 12Gbps SAS-3).*
1	In this mode the model operates in limiting mode. An additional gain of 40dB is included and thus the output peak-to-peak voltage will only depend on the limiting amplitude and not the input peak-to-peak voltage. *This mode should be used for applications which do not require link training.*

4 Transmitter Model Parameters

The DS125MB203 transmitter model includes the following model-specific parameters:

1. **DE_Level**: This parameter sets the driver de-emphasis level setting. There are eight de-emphasis settings as shown in the table below.

Model DE_Level setting	De-emphasis value
0	0 dB
1	-1.5 dB
2	-3.5 dB
3	-5.0 dB
4	-6.0 dB
5	-8.0 dB
6	-9.0 dB
7	-12.0 dB

2. **VOD_Level**: This parameter sets the driver output voltage setting. There are eight VOD settings as shown in the table below. Note that in non-limiting mode (Limit=0), the output peak-to-peak amplitude will depend on the input peak-to-peak amplitude, so the output amplitude may not match the values shown in this table. In limiting model (Limit=1) the output peak-to-peak amplitude is directly controllable with the VOD_Level setting.

Model VOD_Level setting	De-emphasis value
0	700 mVp-p
1	800 mVp-p
2	900 mVp-p
3	1000 mVp-p
4	1100 mVp-p
5	1200 mVp-p
6	1300 mVp-p
7	1400 mVp-p

3. **Gain_debugonly**: This parameter takes on the value of 0.55 and should not be changed by the user. It is included for debug purposes only.

5 Model Usage Tips

The following are general tips for using the DS125MB203 IBIS-AMI model.

1. ***How to set the samples per UI in the simulator***. Samples per UI should be chosen such that the sample time (UI divided by samples per UI) should be less than 10E-12 for accurate results. Typical recommended values for different bit rates are as follows:

Bit rate	Recommended samples per UI setting
≥ 1 Gbps	≥ 128 samples per UI
≥ 4 Gbps	≥ 64 samples per UI
≥ 8 Gbps	≥ 32 samples per UI

2. ***Note on [Repeater Pin]***. The [Repeater Pin] key word in the IBIS file is used to define the Rx input pin and Tx output pin pairs which form repeaters. At the time this document was written, this was not yet part of the official IBIS standard and hence the IBIS parser throws an 'Invalid Keyword' error upon encountering the [Repeater Pin] keyword. Please ignore this error as the model runs fine in most EDA tools (SiSoft QCD and Agilent ADS to name a few). In fact, the [Repeater Pin] definition is necessary to simulate 'Repeater' models in SiSoft QCD. If the model needs to be run in other tools which do not support this keyword (like Mentor Graphics Hyperlynx), the [Repeater Pin] definition can be deleted without any change in the functionality of the model.

6 Model Verification

To verify the functionality and accuracy of the model, comparisons were made between IBIS-AMI model simulations and Cadence transistor-level simulations at different data rates and for different channel media.

6.1 Receiver test #1

Signal source: 8.0 Gbps, 1 V peak-to-peak differential, 0 dB de-emphasis
Channel: 10 meter, 30 AWG copper cable
DS125MB203 EQ_Level: 10
DS125MB203 Limit: 0
Measurement point: Receiver output

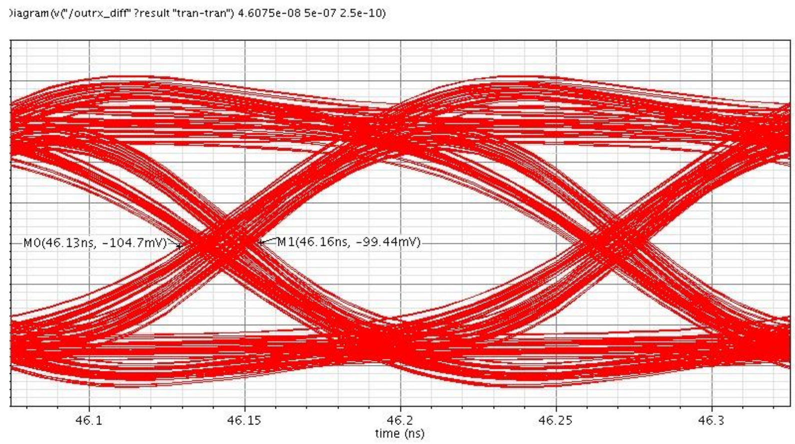
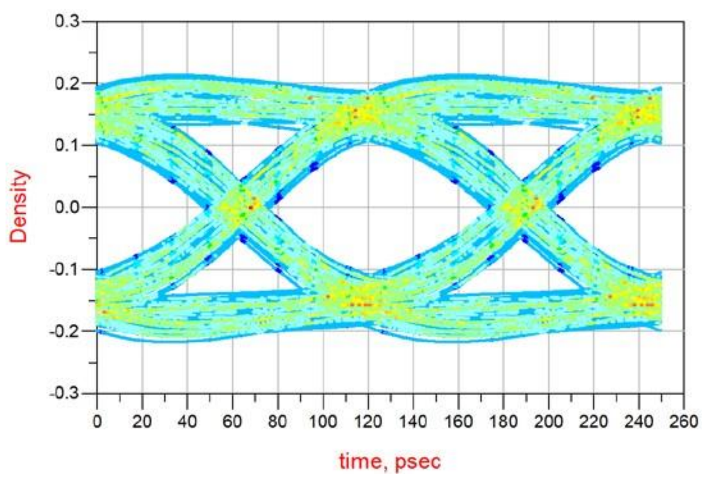


Figure 1: Cadence simulation (Jitter = 30 ps p-p)



measurement	Summary
Level1	0.150
Level0	-0.149
LevelMean	1.710E-4
Amplitude	0.299
Height	0.174
Width	9.625E-11
RiseTime	5.949E-11
FallTime	6.067E-11
JitterPP	2.875E-11
JitterRMS	7.109E-12
WidthAtBER	9.813E-11
HeightAtBER	0.214

Figure 2: IBIS-AMI simulation (Jitter = 29 ps p-p)

6.2 Receiver test #2

Signal source: 8.0 Gbps, 1 V peak-to-peak differential, 0 dB de-emphasis
Channel: 10 inches, 4 mil stripline
DS125MB203 EQ_Level: 6*
DS125MB203 Limit: 0
Measurement point: Receiver output
**This test case is to deliberately show over-equalization*

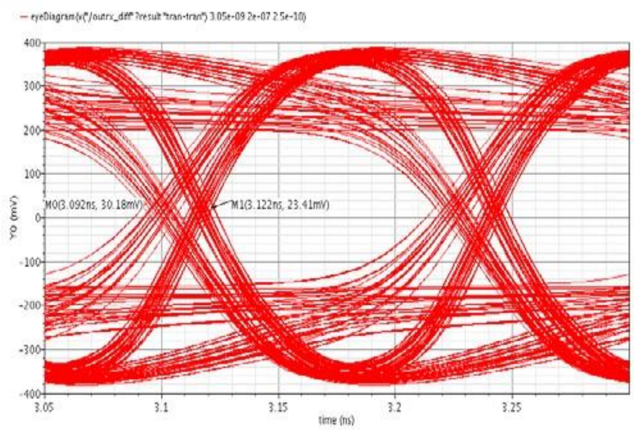
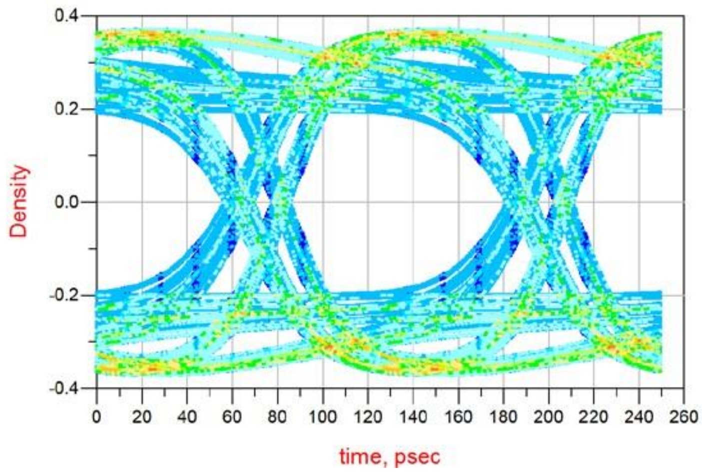


Figure 3: Cadence simulation (Jitter = 30 ps p-p)



measurement	Summary
Level1	0.300
Level0	-0.301
LevelMean	-3.958E-4
Amplitude	0.600
Height	0.347
Width	9.625E-11
RiseTime	4.745E-11
FallTime	5.028E-11
JitterPP	2.875E-11
JitterRMS	9.840E-12
WidthAtBER	9.500E-11
HeightAtBER	0.390

Figure 4: IBIS-AMI simulation (Jitter = 29 ps p-p)

6.3 Receiver test #3

Signal source: 10.3125 Gbps, 1 V peak-to-peak differential, 0 dB de-emphasis
Channel: 20 inches, 4 mil stripline
DS125MB203 EQ_Level: 6
DS125MB203 Limit: 0
Measurement point: Receiver output

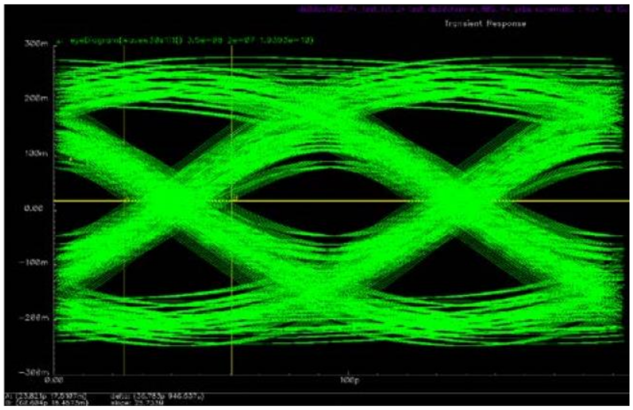
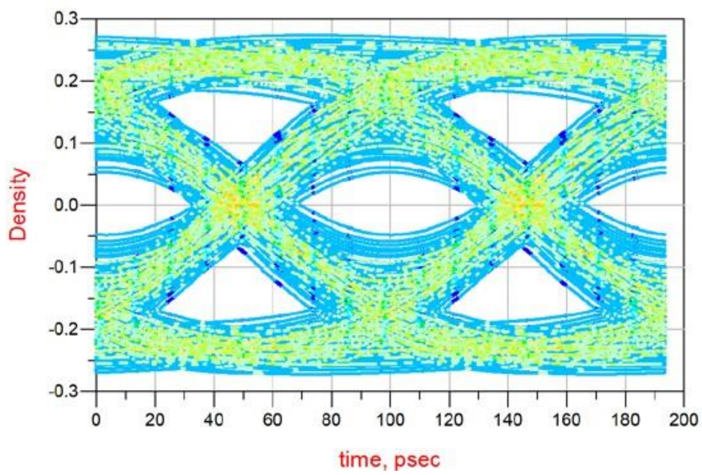


Figure 5: Cadence simulation (Jitter = 37 ps p-p)



measurement	Summary
Level1	0.173
Level0	-0.173
LevelMean	6.445E-5
Amplitude	0.345
Height	0.082
Width	6.061E-11
RiseTime	6.491E-11
FallTime	6.304E-11
JitterPP	3.636E-11
JitterRMS	7.848E-12
WidthAtBER	6.158E-11
HeightAtBER	0.099

Figure 6: IBIS-AMI simulation (Jitter = 36 ps p-p)

6.4 Receiver test #4

Signal source: 12.5 Gbps, 1 V peak-to-peak differential, 0 dB de-emphasis
Channel: 20 inches, 4 mil stripline
DS125MB203 EQ_Level: 8
DS125MB203 Limit: 0
Measurement point: Receiver output

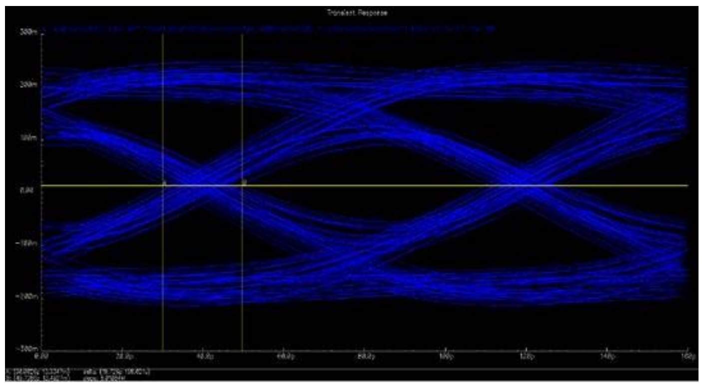
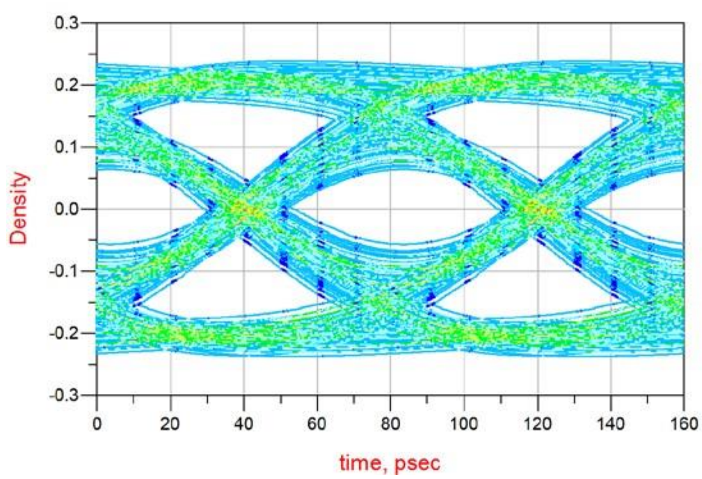


Figure 7: Cadence simulation (Jitter = 20 ps p-p)



measurement	Summary
Level1	0.152
Level0	-0.152
LevelMean	1.528E-4
Amplitude	0.304
Height	0.104
Width	5.560E-11
RiseTime	5.484E-11
FallTime	5.340E-11
JitterPP	2.408E-11
JitterRMS	4.816E-12
WidthAtBER	5.760E-11
HeightAtBER	0.120

Figure 8: IBIS-AMI simulation (Jitter = 24 ps p-p)

6.5 Transmitter test #1

Signal source: 12.5 Gbps, 0.6 V peak-to-peak differential, 0 dB de-emphasis
Channel: 10 inches, 4 mil stripline
DS125MB203 DE_Level: 2
DS125MB203 VOD_Level: 4
Measurement point: Far-end channel output

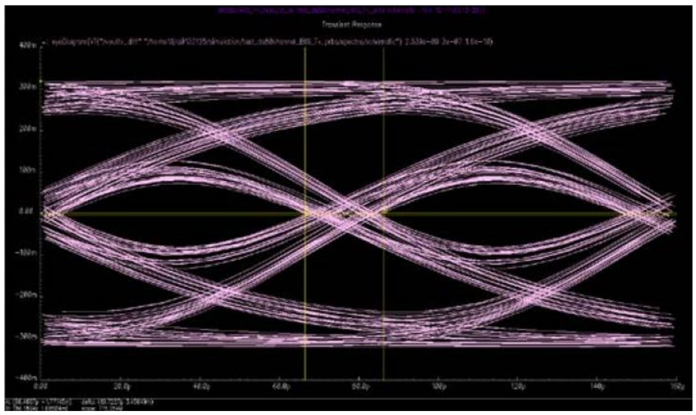
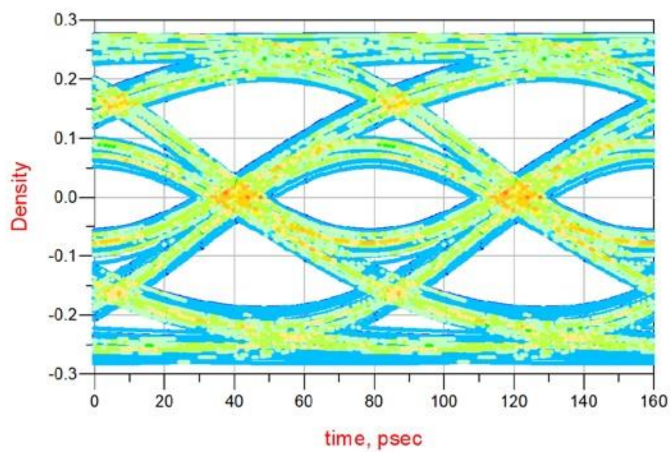


Figure 9: Cadence simulation (Jitter = 20 ps p-p)



measurement	Summary
Level1	0.164
Level0	-0.163
Amplitude	0.327
Height	0.098
HeightDB	-10.088
Width	5.800E-11
RiseTime	5.322E-11
FallTime	5.210E-11
JitterPP	2.200E-11
JitterRMS	5.255E-12
WidthAtBER	5.840E-11
HeightAtBER	0.107
CrossingLevel	-0.002

Figure 10: IBIS-AMI simulation (Jitter = 22 ps p-p)

6.6 Full channel test #1

Signal source: 8.0 Gbps, 1 V peak-to-peak differential, 0 dB de-emphasis
RX channel: 20 inches, 4 mil stripline
TX channel: 10 inches, 4 mil stripline

DS125MB203 EQ_Level: 4
DS125MB203 Limit: 0
DS125MB203 DE_Level: 2
DS125MB203 VOD_Level: 7
Measurement points: Receiver output and far-end channel output

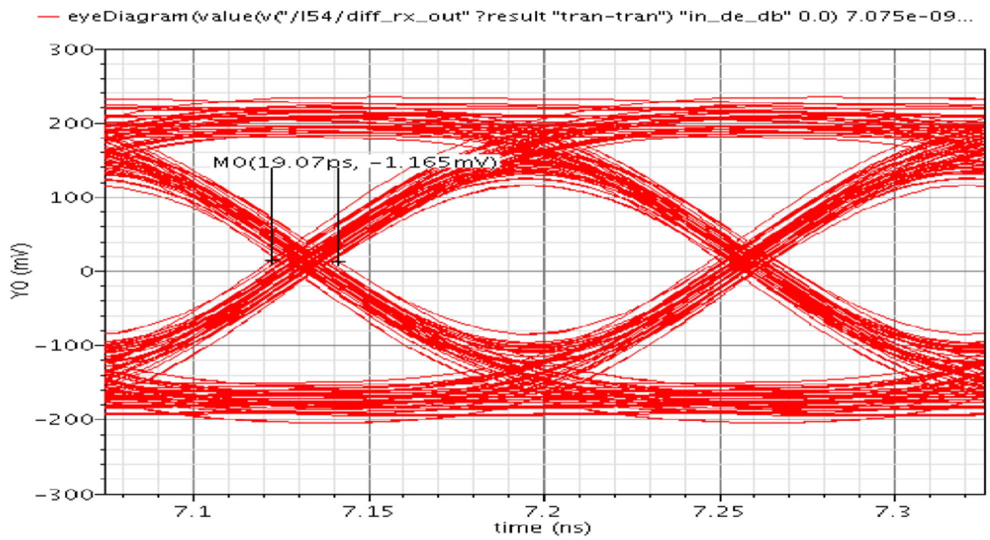


Figure 11: Cadence simulation, RX output (Jitter = 19 ps p-p)

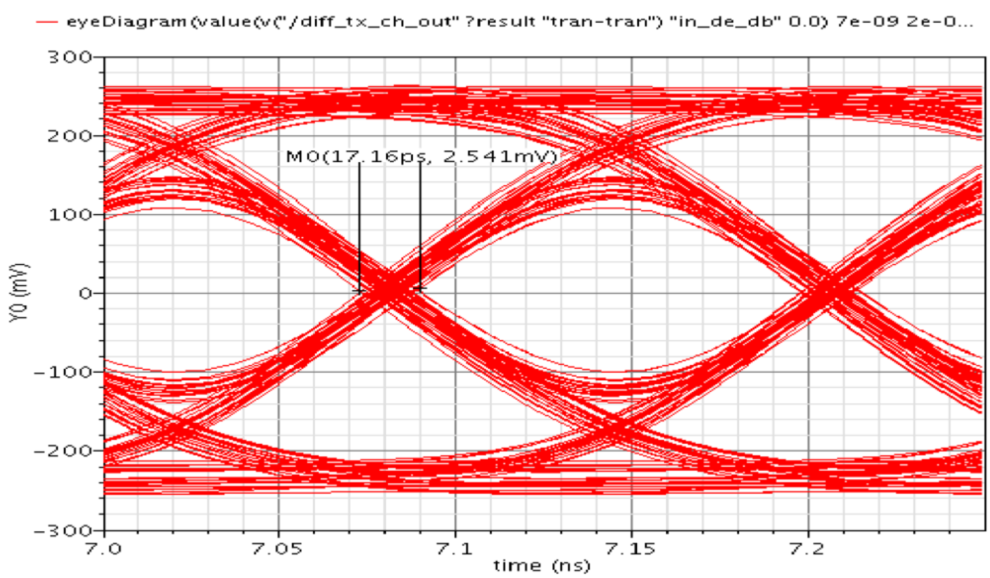
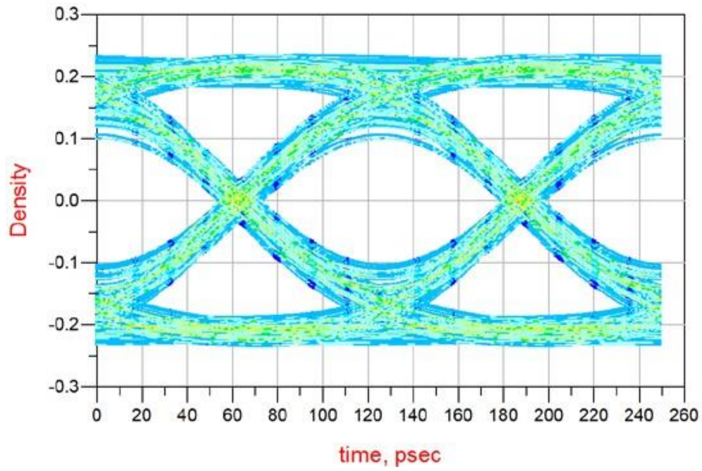
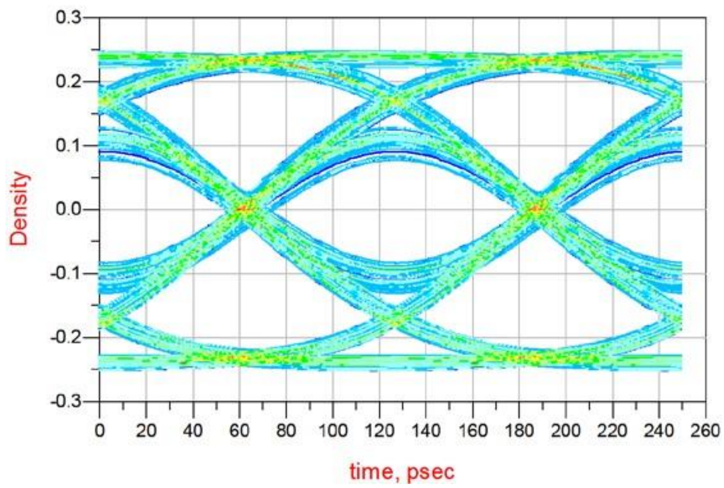


Figure 12: Cadence simulation, far-end channel output (Jitter = 17 ps p-p)



measurement	Summary
Level1	0.171
Level0	-0.171
LevelMean	1.023E-4
Amplitude	0.342
Height	0.187
Width	1.044E-10
RiseTime	7.287E-11
FallTime	7.068E-11
JitterPP	2.063E-11
JitterRMS	4.799E-12
WidthAtBER	1.063E-10
HeightAtBER	0.201

Figure 13: IBIS-AMI simulation, RX output (Jitter = 21 ps p-p)



measurement	Summary
Level1	0.171
Level0	-0.170
Amplitude	0.341
Height	0.146
HeightDB	-8.356
Width	1.044E-10
RiseTime	8.332E-11
FallTime	8.338E-11
JitterPP	2.063E-11
JitterRMS	4.160E-12
WidthAtBER	1.056E-10
HeightAtBER	0.160
CrossingLevel	0.000

Figure 14: IBIS-AMI simulation, far-end channel output (Jitter = 21 ps p-p)

6.7 Full channel test #2

Signal source: 8.0 Gbps, 1 V peak-to-peak differential, 9 dB de-emphasis*
RX channel: 20 inches, 4 mil stripline
TX channel: 10 inches, 4 mil stripline
DS125MB203 EQ_Level: 4
DS125MB203 Limit: 0
DS125MB203 DE_Level: 2
DS125MB203 VOD_Level: 7
Measurement points: Receiver output and far-end channel output
**This test case is deliberately over-equalized to show how source de-emphasis passes through the repeater*

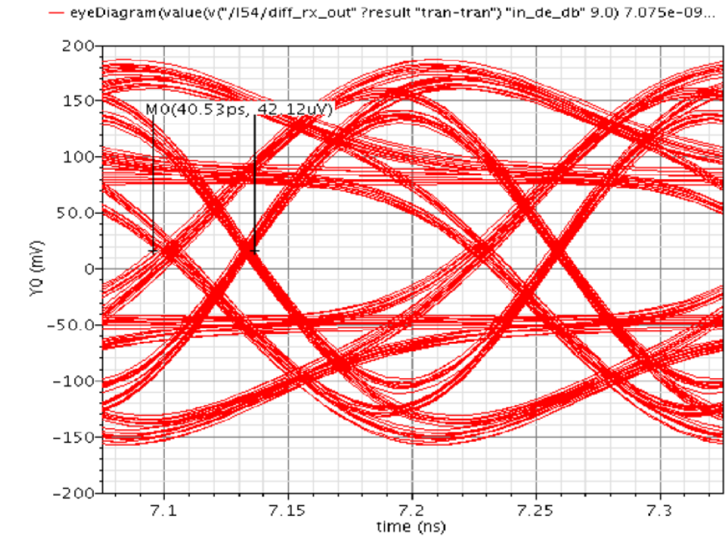


Figure 15: Cadence simulation, RX output (Jitter = 41 ps p-p)

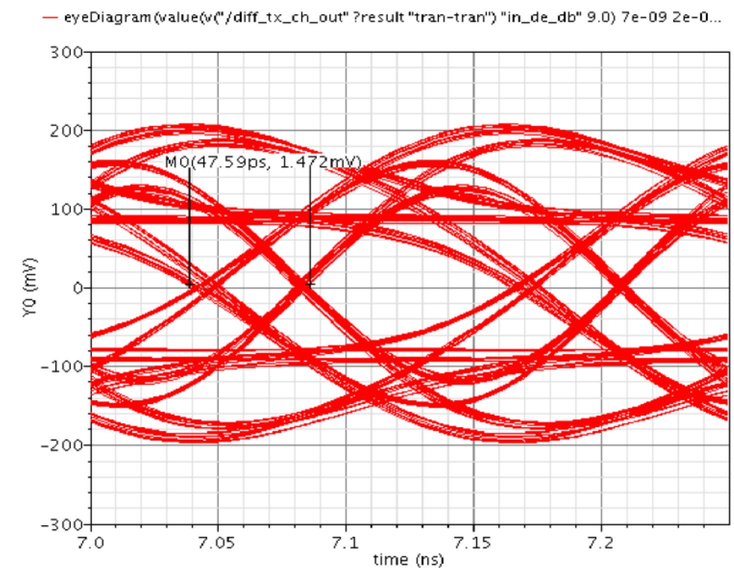
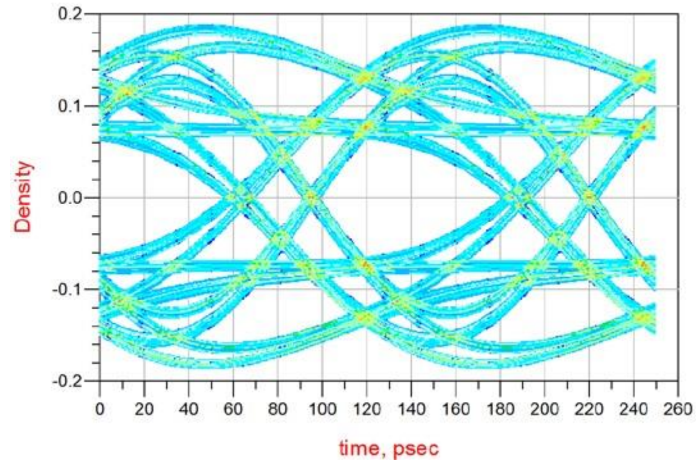
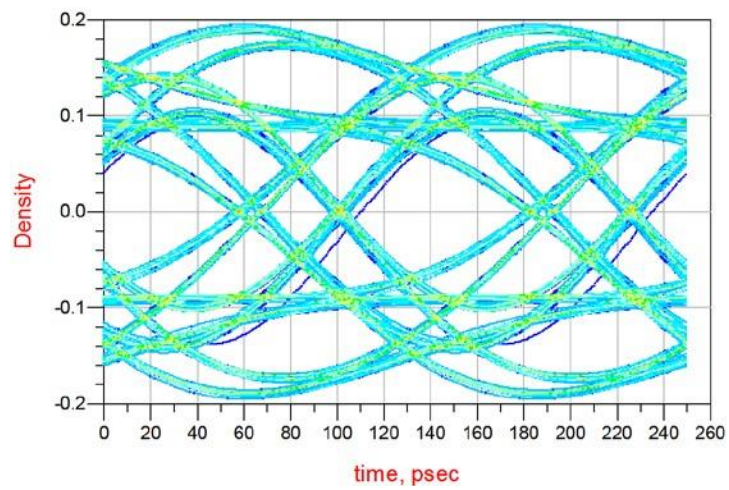


Figure 16: Cadence simulation, far-end channel output (Jitter = 48 ps p-p)



measurement	Summary
Level1	0.114
Level0	-0.114
LevelMean	-1.298E-4
Amplitude	0.228
Height	0.056
Width	8.188E-11
RiseTime	5.164E-11
FallTime	6.587E-11
JitterPP	4.313E-11
JitterRMS	1.664E-11
WidthAtBER	8.188E-11
HeightAtBER	0.127

Figure 17: IBIS-AMI simulation, RX output (Jitter = 43 ps p-p)



measurement	Summary
Level1	0.112
Level0	-0.112
Amplitude	0.224
Height	0.082
HeightDB	-10.862
Width	7.063E-11
RiseTime	6.753E-11
FallTime	6.763E-11
JitterPP	5.438E-11
JitterRMS	1.970E-11
WidthAtBER	7.250E-11
HeightAtBER	0.123
CrossingLevel	-0.005

Figure 18: IBIS-AMI simulation, far-end channel output (Jitter = 54 ps p-p)