25 Spring ECEN 720: High-Speed Links: Circuits and Systems Post-lab Report

Lab6: Link Modeling with ADS

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Section:700

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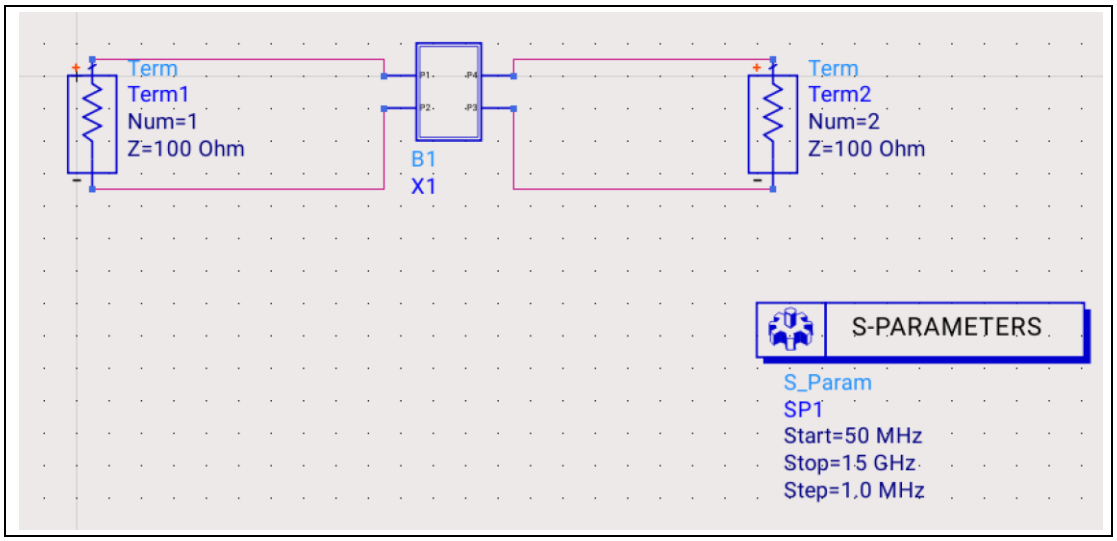
1. Using the ADS, analyze the following test cases. Use 1" Backplane s-parameter (B1). At 8Gb/s, include packaging parasitic as depicted in Figure 5 for chip-to-chip interconnect. Assume 500um Bonding wire with bonding pad capacitance of 200fF, and neglect the mutual wire inductance and pin parasitic for realistic termination modeling. Please, refer to [2] for step-by-step guide on using ADS for Signal Integrity Design. For all test cases use 1Vpp swing at TX.

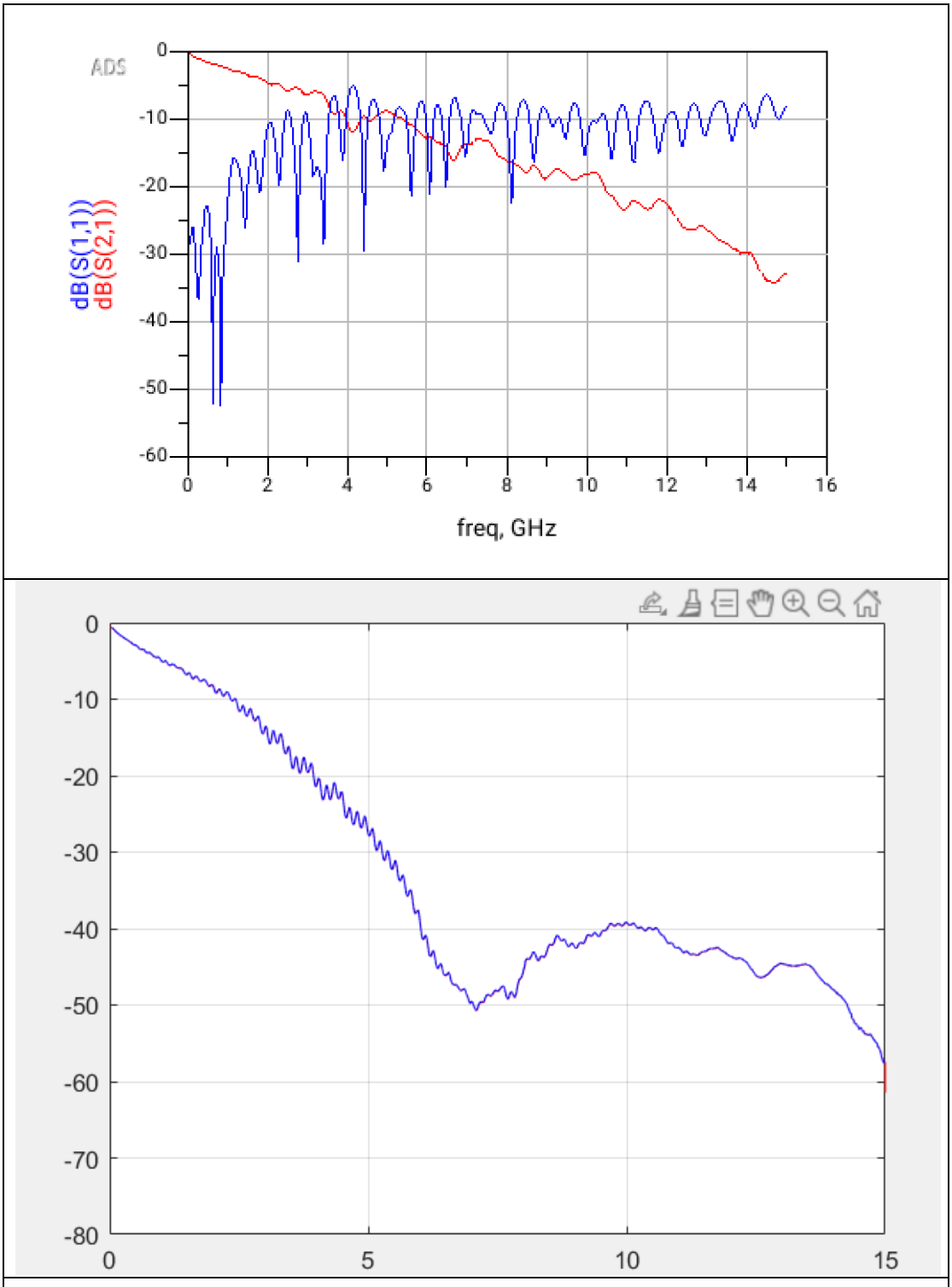
(a) Using ADS, plot Insertion Loss and Return Loss from 50MHz to 15GHz. Compare with MATLAB plot.

(b) Show eye diagrams, and BER contours, and BER bathtub curves both in time and voltage for the following test cases. Include all schematics on the lab report. - - - -
Case 1: Only the forward channel (thru channel) including TX and RX with ideal 100Ω differential terminations without any cross talk.
Case 2: Use the forward channel in Case 1 with an aggressor (FEXT1, NEXT1) terminated with an ideal 100Ω differential load.
Case 3: Use the forward channel in Case 1 with realistic terminations (i.e. including parasitics).
Case 4: Use the forward channel with an ideally terminated aggressor similar to Case 2 with realistic terminations (i.e. including parasitics).

(c) Repeat (b) with non-ideal transceiver jitter properties,

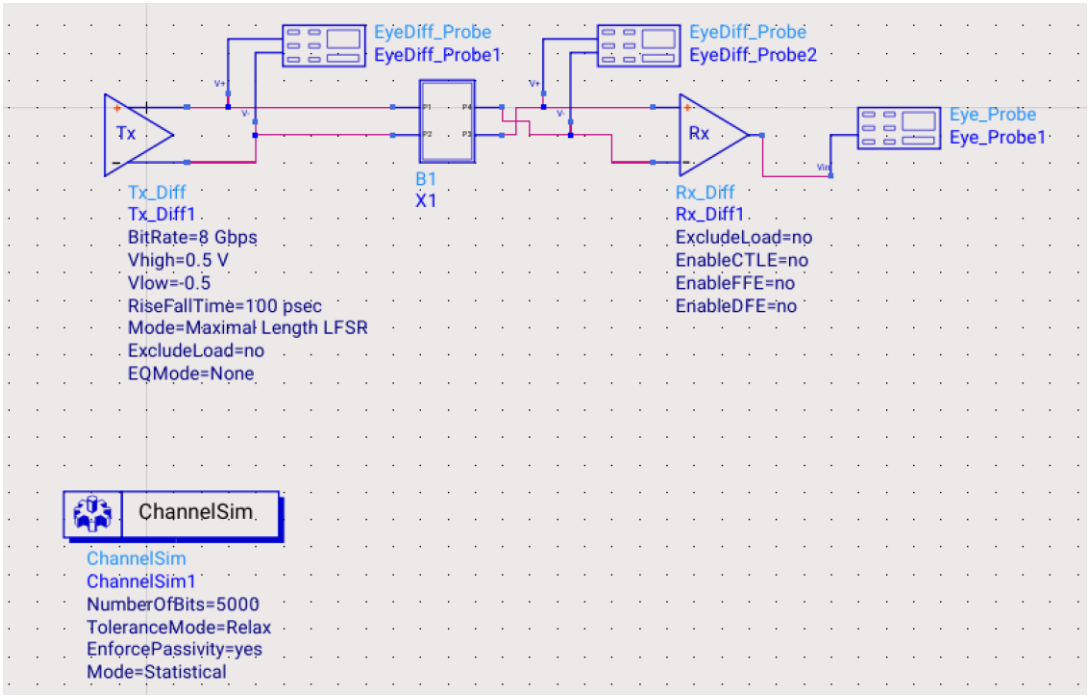
- TX
  - DCD = 0.04UI; Clock DCD = 0.04UI
  - RJ = 0.01UI
  - Load = 100 Ohm
  - De-emphasis = 3dB
- RX
  - No FFE, No DFE
  - Load = 100 Ohm
  - RJ = 0.01 Sigma
  - Amplitude noise = 1mV

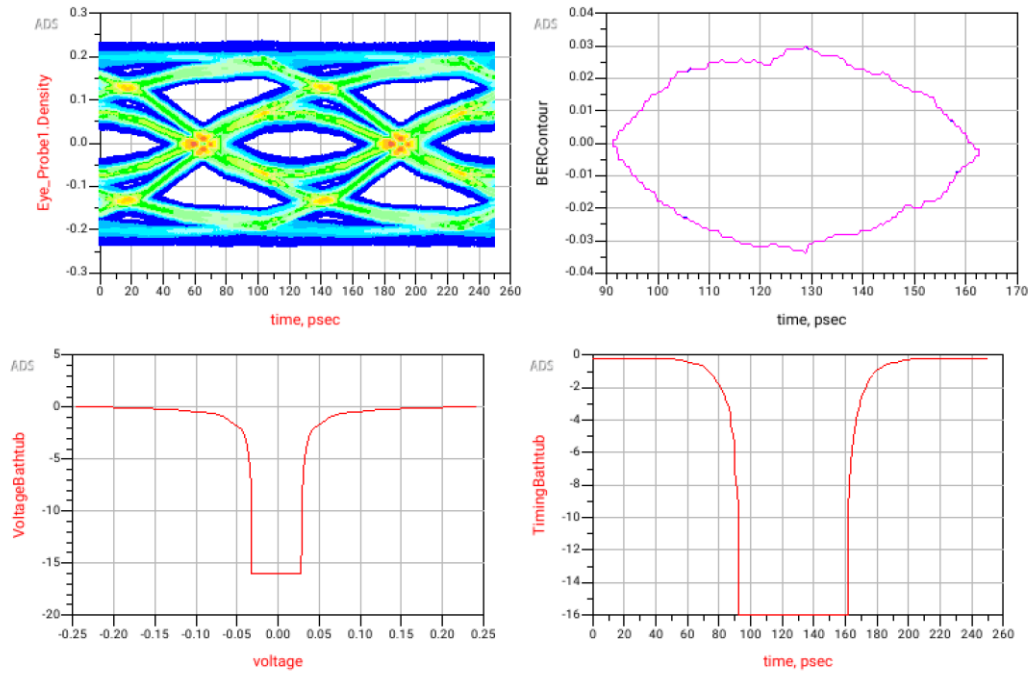


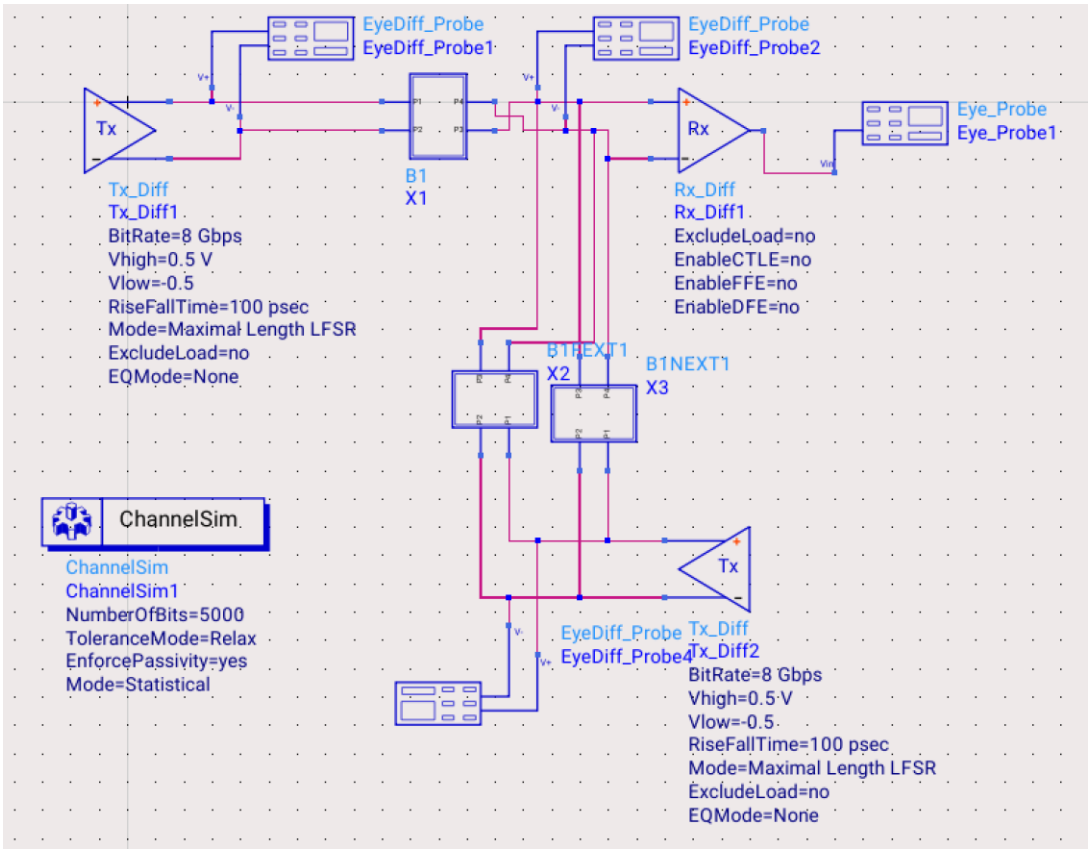

ADS
dB(S(1,1))
dB(S(2,1))
freq, GHz
0
-10
-20
-30
-40
-50
-60
0
2
4
6
8
10
12
14
16

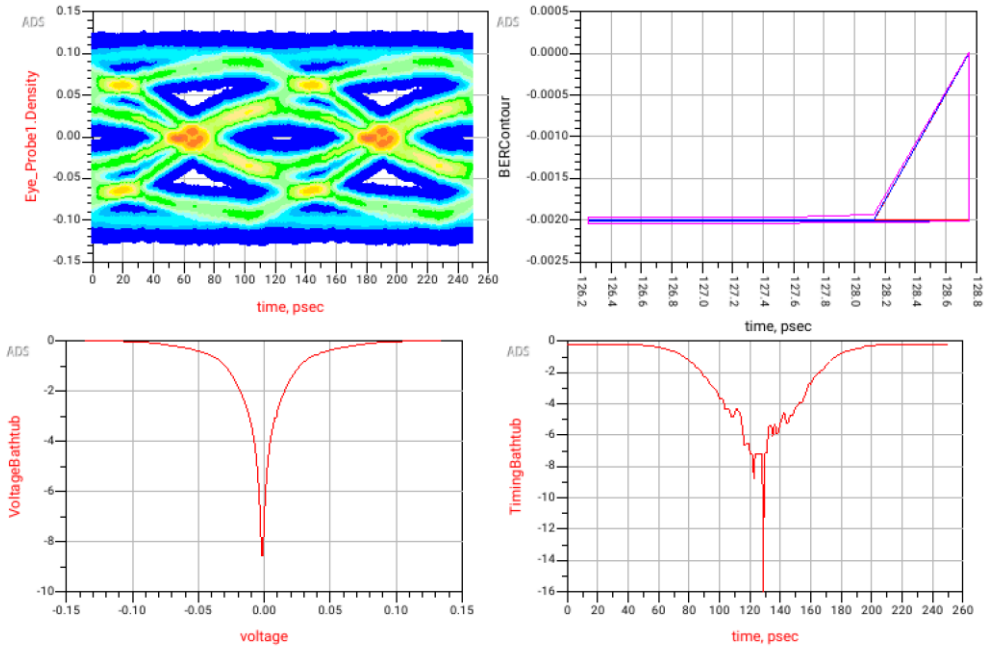
0
-10
-20
-30
-40
-50
-60
-70
-80
0
5
10
15

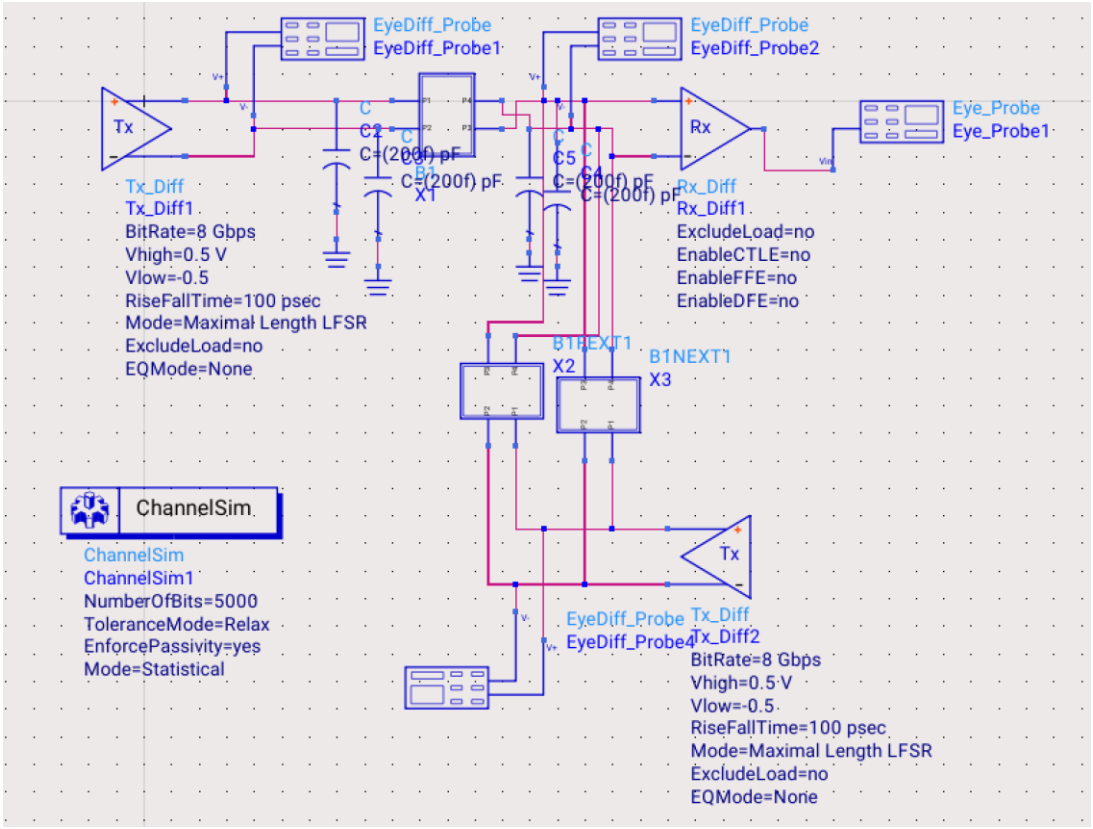
B

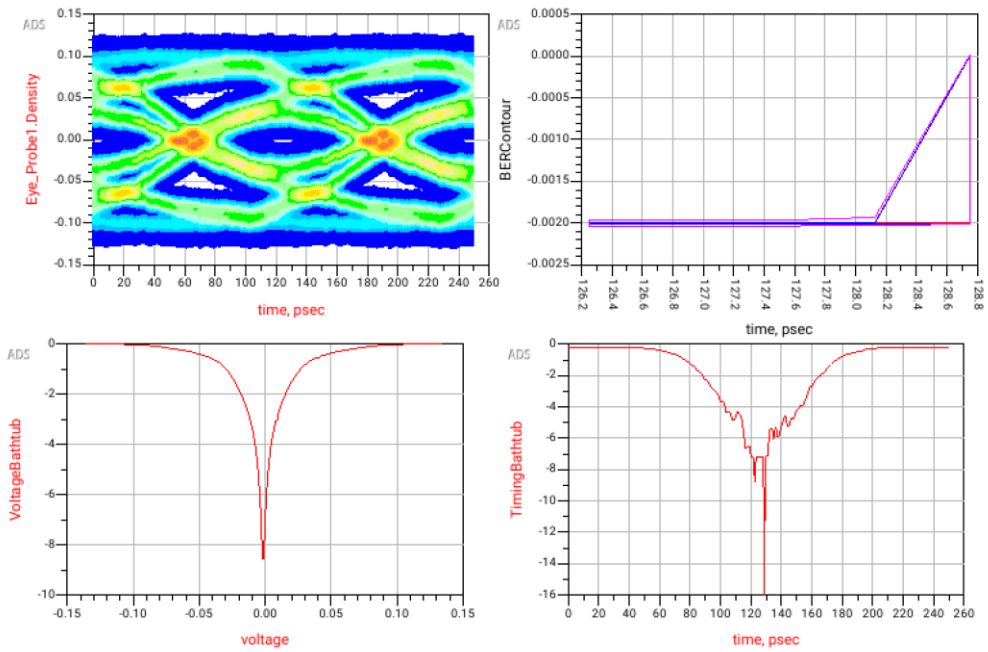

EyeDiff_Probe
EyeDiff_Probe1
EyeDiff_Probe
EyeDiff_Probe2
Eye_Probe
Eye_Probe1
Tx
Rx
B1
X1
Tx_Diff
Tx_Diff1
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=None
Rx_Diff
Rx_Diff1
ExcludeLoad=no
EnableCTLE=no
EnableFFE=no
EnableDFE=no
ChannelSim
ChannelSim
ChannelSim1
NumberOfBits=5000
ToleranceMode=Relax
EnforcePassivity=yes
Mode=Statistical

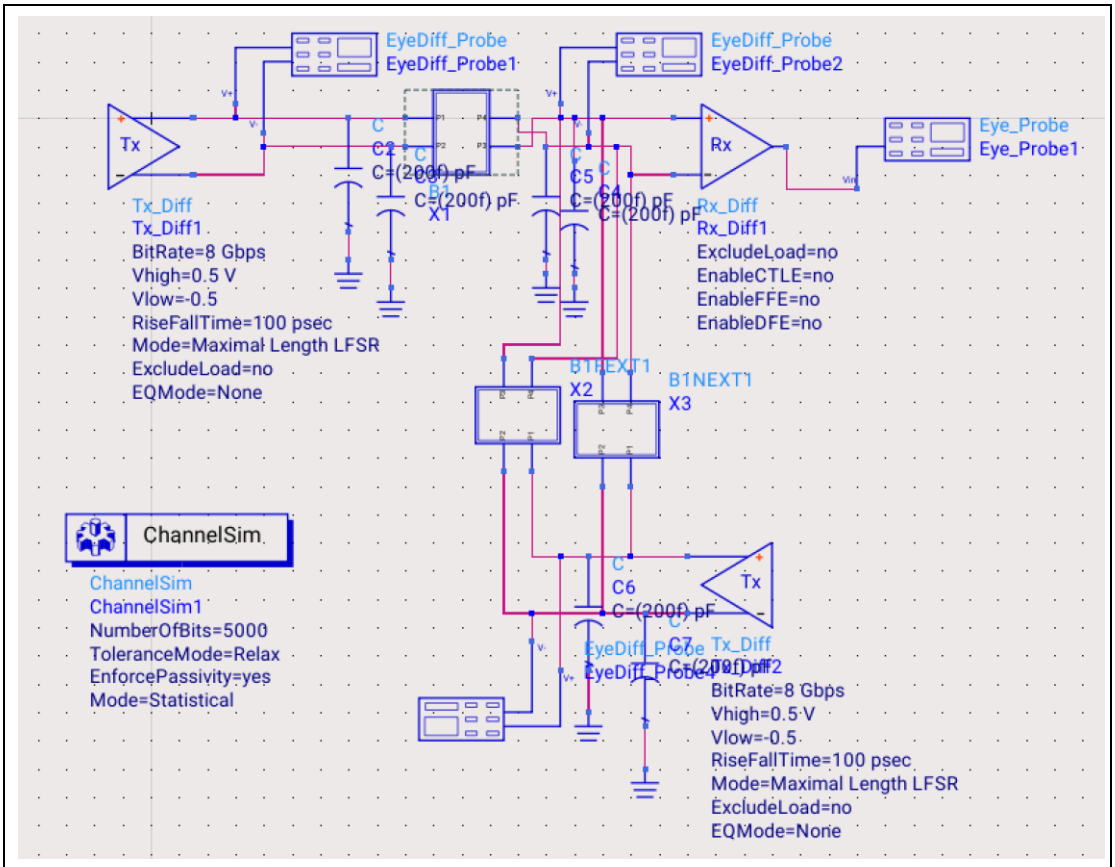

ADS
Eye_Probe1.Density
time, psec
ADS
BERContour
time, psec
ADS
VoltageBathtub
voltage
ADS
TimingBathtub
time, psec

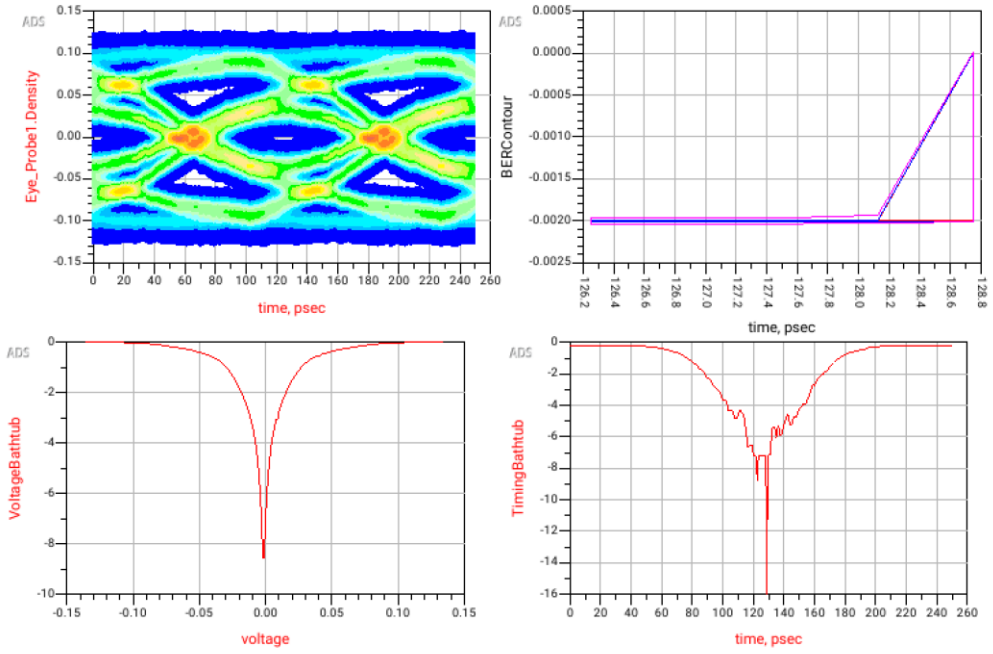

EyeDiff_Probe
EyeDiff_Probe1
EyeDiff_Probe
EyeDiff_Probe2
Eye_Probe
Eye_Probe1
Tx
Rx
B1
X1
Tx_Diff
Tx_Diff1
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=None
Rx_Diff
Rx_Diff1
ExcludeLoad=no
EnableCTLE=no
EnableFFE=no
EnableDFE=no
B1NEXT1
X2
B1NEXT1
X3
ChannelSim
ChannelSim
ChannelSim1
NumberOfBits=5000
ToleranceMode=Relax
EnforcePassivity=yes
Mode=Statistical
Tx
EyeDiff_Probe
EyeDiff_Probe4
Tx_Diff
Tx_Diff2
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=None


Eye_Probe1.Density
time, psec
BERContour
time, psec
VoltageBathtub
voltage
TimingBathtub
time, psec

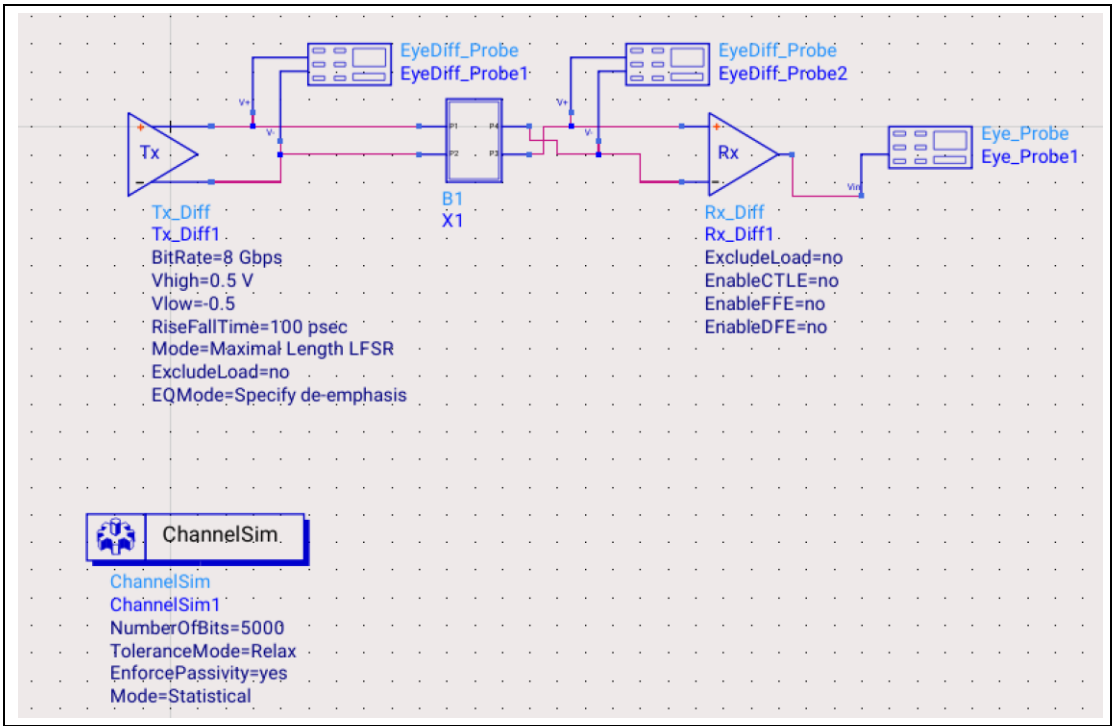

EyeDiff_Probe
EyeDiff_Probe1
EyeDiff_Probe
EyeDiff_Probe2
Eye_Probe
Eye_Probe1
Tx
Rx
C
C2
C=(200f) pF
X1
C
C5
C=(200f) pF
Tx_Diff
Tx_Diff1
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=None
Rx_Diff
Rx_Diff1
ExcludeLoad=no
EnableCTLE=no
EnableFFE=no
EnableDFE=no
B1NEXT1
X2
B1NEXT1
X3
ChannelSim
ChannelSim
ChannelSim1
NumberOfBits=5000
ToleranceMode=Relax
EnforcePassivity=yes
Mode=Statistical
Tx
EyeDiff_Probe
EyeDiff_Probe4
Tx_Diff
Tx_Diff2
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=None

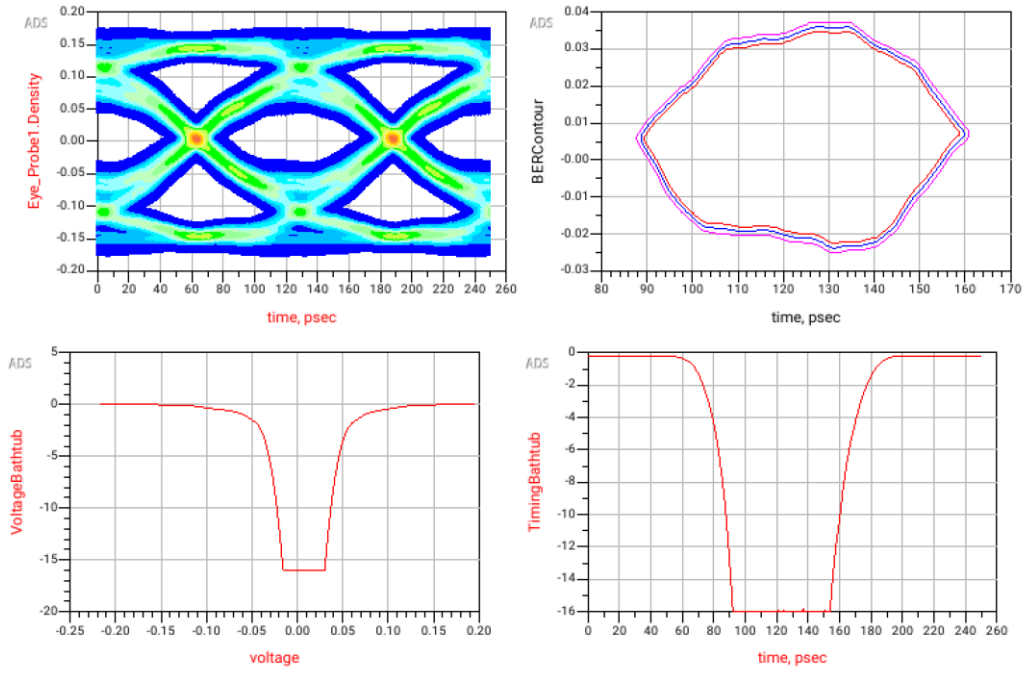

ADS
Eye_Probe1.Density
time, psec
ADS
BERContour
time, psec
ADS
VoltageBathtub
voltage
ADS
TimingBathtub
time, psec

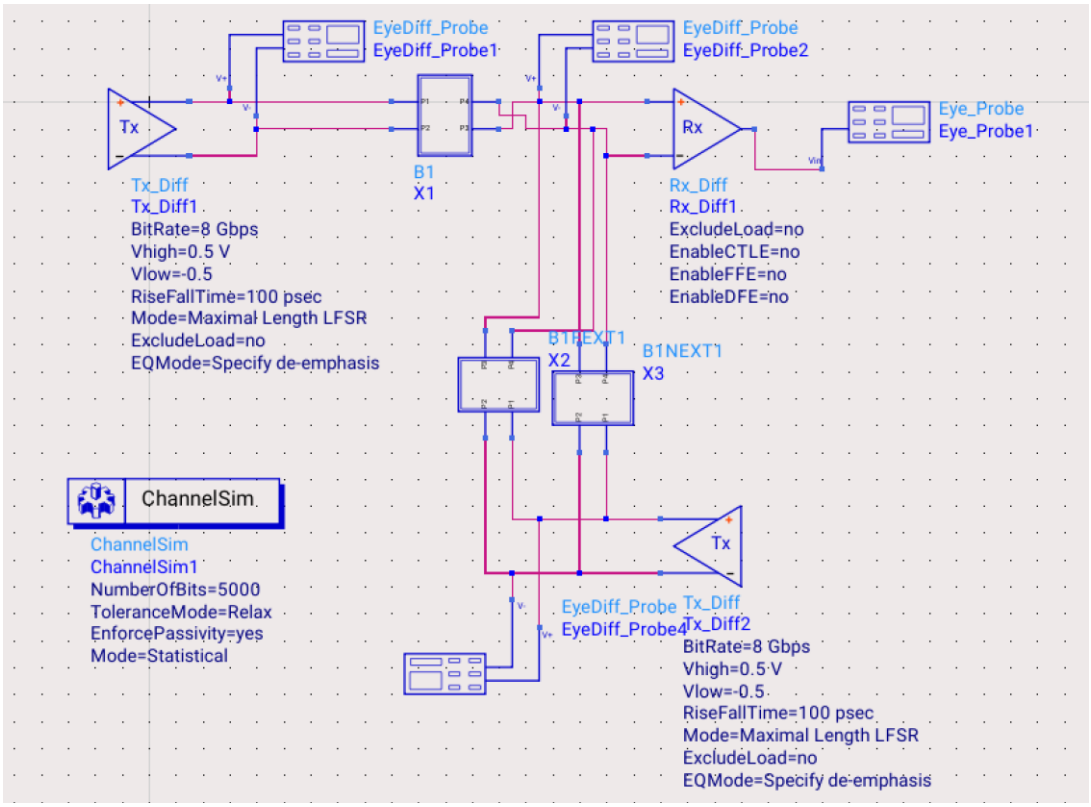

EyeDiff_Probe
EyeDiff_Probe1
EyeDiff_Probe
EyeDiff_Probe2
Eye_Probe
Eye_Probe1
Tx
Rx
Tx_Diff
Tx_Diff1
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=None
C
C2
C=(200f) pF
C
C3
C=(200f) pF
X1
C
C5
C=(200f) pF
C
C4
C=(200f) pF
Rx_Diff
Rx_Diff1
ExcludeLoad=no
EnableCTLE=no
EnableFFE=no
EnableDFE=no
B1NEXT1
X2
B1NEXT1
X3
ChannelSim
ChannelSim
ChannelSim1
NumberOfBits=5000
ToleranceMode=Relax
EnforcePassivity=yes
Mode=Statistical
C
C6
C=(200f) pF
Tx
EyeDiff_Probe
EyeDiff_Probe4
C
C7
C=(200f) pF
Tx_Diff
Tx_Diff2
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=None

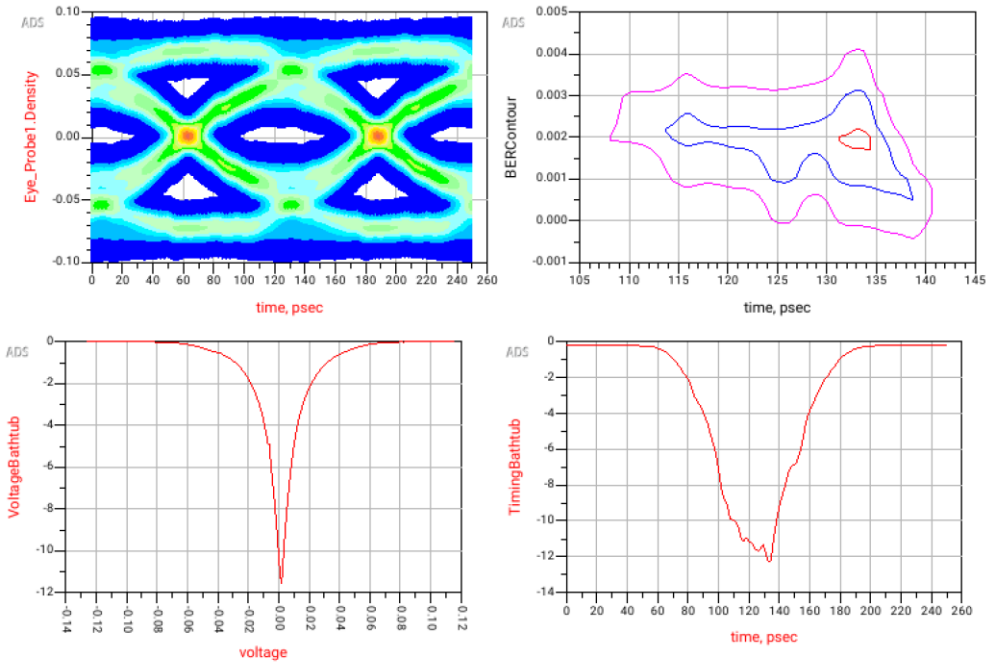

ADS
Eye_Probe1.Density
time, psec
ADS
BERContour
time, psec
ADS
VoltageBathtub
voltage
ADS
TimingBathtub
time, psec

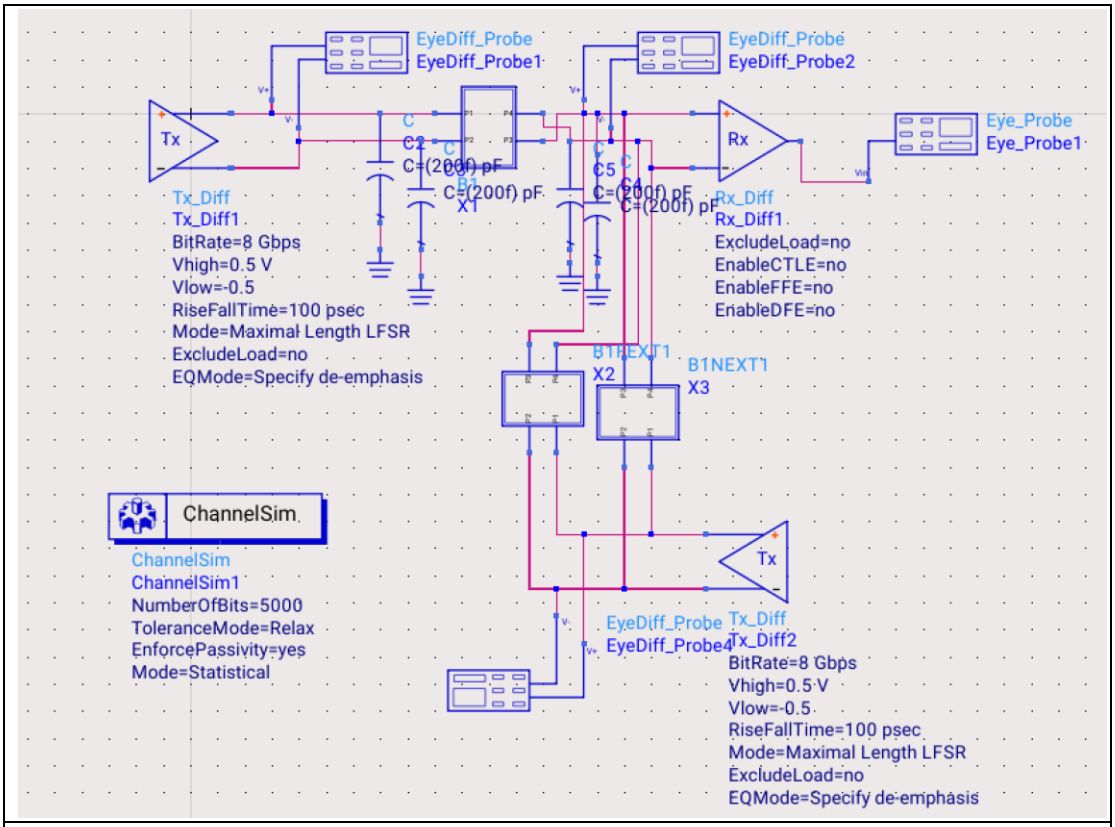
(c)

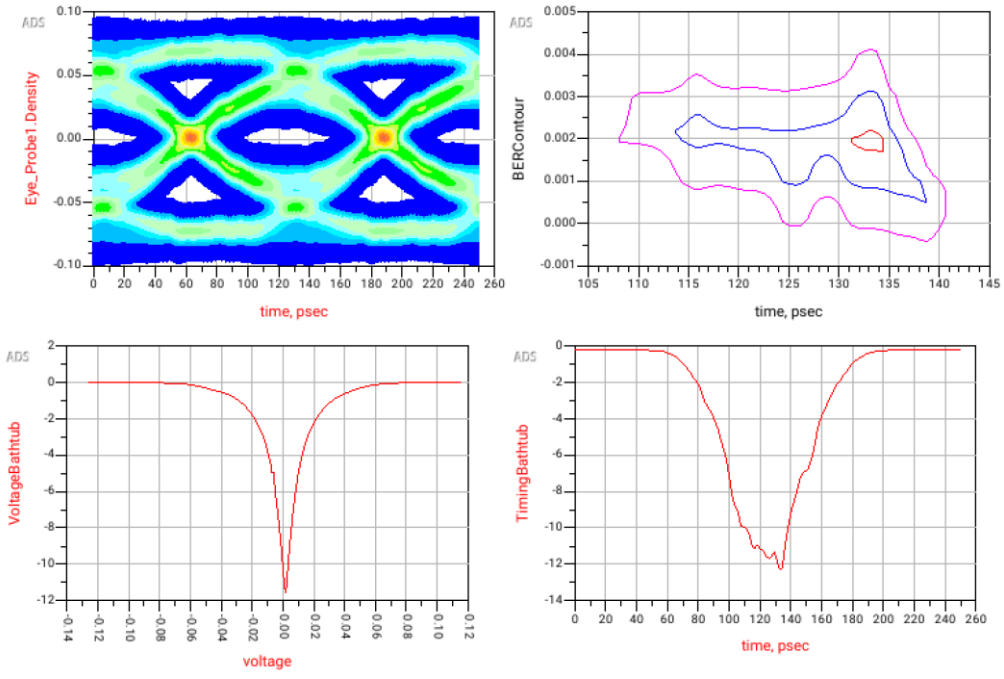

EyeDiff_Probe
EyeDiff_Probe1
EyeDiff_Probe
EyeDiff_Probe2
Tx
Rx
Eye_Probe
Eye_Probe1
B1
X1
Tx_Diff
Tx_Diff1
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=Specify de-emphasis
Rx_Diff
Rx_Diff1
ExcludeLoad=no
EnableCTLE=no
EnableFFE=no
EnableDFE=no
ChannelSim
ChannelSim
ChannelSim1
NumberOfBits=5000
ToleranceMode=Relax
EnforcePassivity=yes
Mode=Statistical

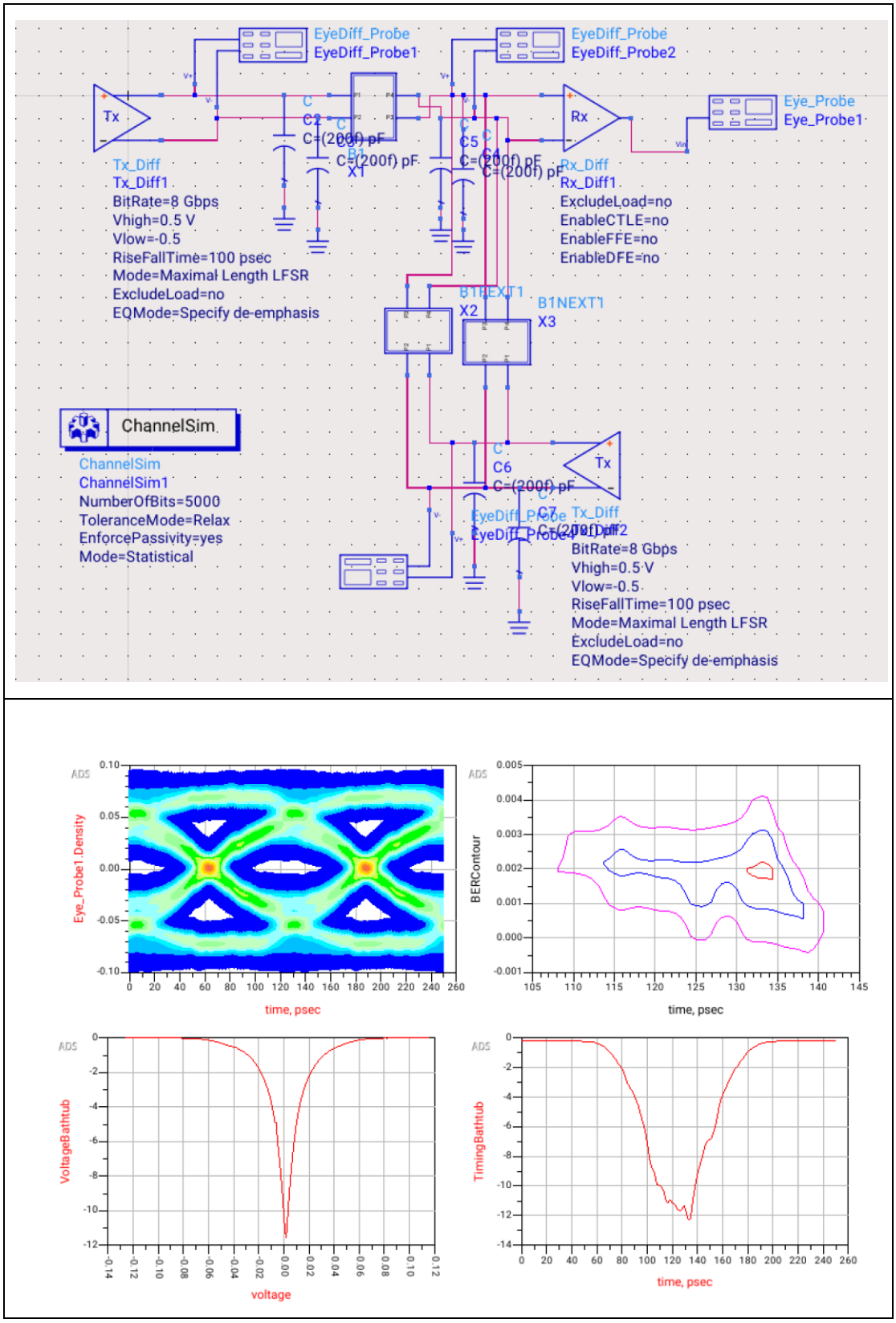

ADS
Eye_Probe1.Density
time, psec
ADS
BERContour
time, psec
ADS
VoltageBathtub
voltage
ADS
TimingBathtub
time, psec


EyeDiff_Probe
EyeDiff_Probe1
EyeDiff_Probe
EyeDiff_Probe2
Tx
Rx
Eye_Probe
Eye_Probe1
B1
X1
Tx_Diff
Tx_Diff1
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=Specify de-emphasis
Rx_Diff
Rx_Diff1
ExcludeLoad=no
EnableCTLE=no
EnableFFE=no
EnableDFE=no
B1NEXT1
X2
B1NEXT1
X3
ChannelSim
ChannelSim
ChannelSim1
NumberOfBits=5000
ToleranceMode=Relax
EnforcePassivity=yes
Mode=Statistical
Tx
EyeDiff_Probe
EyeDiff_Probe4
Tx_Diff
Tx_Diff2
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=Specify de-emphasis


ADS
Eye_Probe1.Density
time, psec
ADS
BERContour
time, psec
ADS
VoltageBathtub
voltage
ADS
TimingBathtub
time, psec


EyeDiff_Probe
EyeDiff_Probe1
EyeDiff_Probe
EyeDiff_Probe2
Eye_Probe
Eye_Probe1
Tx
Rx
C
C2
C=(200f) pF
C
C5
C=(200f) pF
C
C4
C=(200f) pF
X1
Tx_Diff
Tx_Diff1
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=Specify de-emphasis
Rx_Diff
Rx_Diff1
ExcludeLoad=no
EnableCTLE=no
EnableFFE=no
EnableDFE=no
B1NEXT1
X2
B1NEXT1
X3
ChannelSim
ChannelSim
ChannelSim1
NumberOfBits=5000
ToleranceMode=Relax
EnforcePassivity=yes
Mode=Statistical
Tx
EyeDiff_Probe
EyeDiff_Probe4
Tx_Diff
Tx_Diff2
BitRate=8 Gbps
Vhigh=0.5 V
Vlow=-0.5
RiseFallTime=100 psec
Mode=Maximal Length LFSR
ExcludeLoad=no
EQMode=Specify de-emphasis


ADS
Eye_Probe1.Density
time, psec
ADS
BERContour
time, psec
ADS
VoltageBathtub
voltage
ADS
TimingBathtub
time, psec



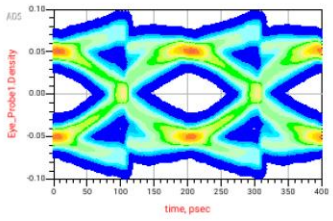
2. Use ADS to model a 5Gb/s link that operates on 20” BP channel (T20_thru) with various equalization schemes including crosstalk aggressors (NEXT1 & FEXT1). Include the same jitter properties and packaging parasitics as Problem 1 for all

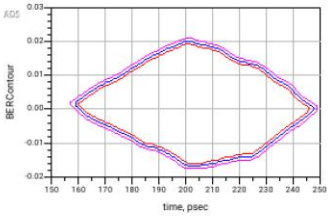
test cases. You should provide your own CTLE poles and zero(s) in the RX block. Also, include TX FIR taps. For all test cases use 1Vpp swing at TX. Show eye diagrams, BER bathtub curves, BER contours in the following cases in Table 3. Plot the eye heights vs. Case # at BER of 10-12.

Table 3 Test Cases

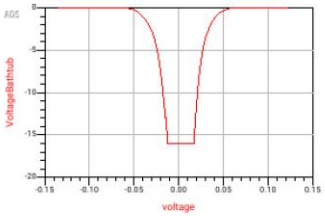
	TX FIR	RX
case 1	1 Pre	2 Taps DFE
case 2	1 Post	1 Taps DFE
case 3	1 Pre	CTLE+1 Taps DFE
case 4	1 Post	CTLE+1 Taps DFE
case 5	1 Pre-1 Post	1 Taps DFE
case 6	1 Pre-1 Post	3 Taps DFE
case 7	1 Pre-1 Post	5 Taps DFE

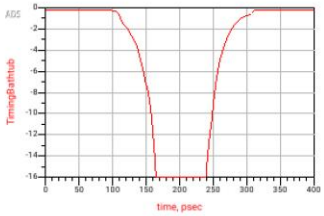
CASE1





index	...ute(Eye_Probe1.Height)
0.000	0.055



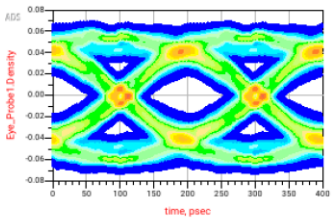


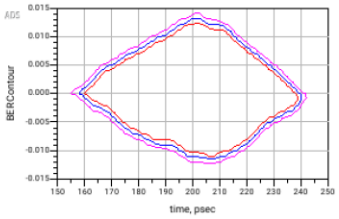

```
taps_quan =

   -0.1429    0.8571
```

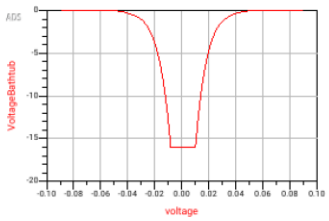
(3 bits resolution)

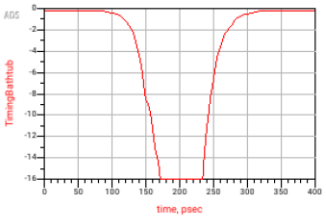
CASE2





index	...ute(Eye_Probe1.Height)
0.000	0.035



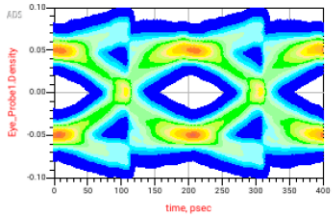


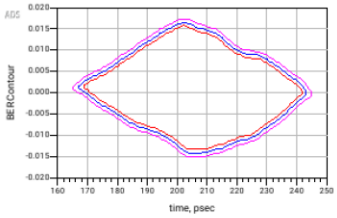

```
taps_quan =

    0.7143   -0.2857
```

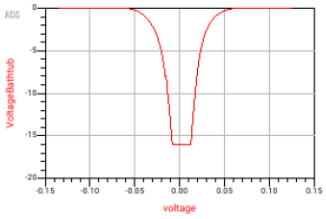
(3 bits resolution)

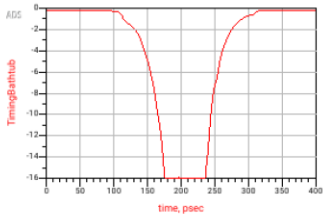
CASE3



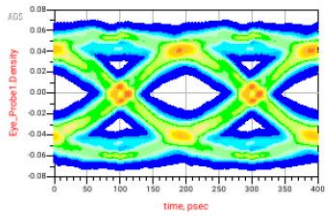


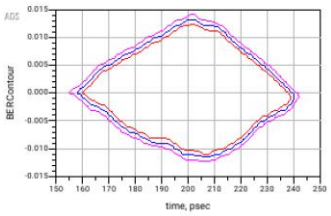
index	...ute(Eye_Probe1.Height)
0.000	0.047



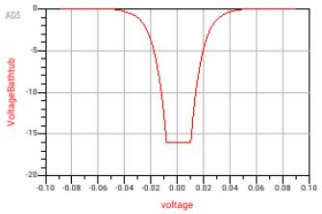


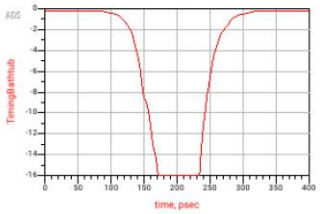
CASE4



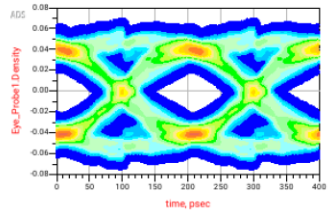


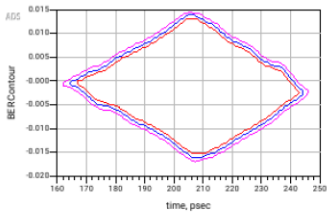
index	...ute(Eye_Probe1.Height)
0.000	0.035



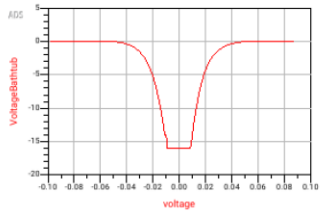


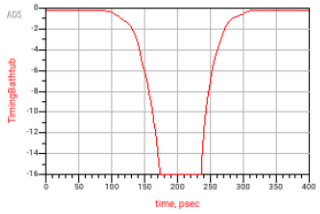
CASE5





index	...ute(Eye_Probe1.Height)
0.000	0.041



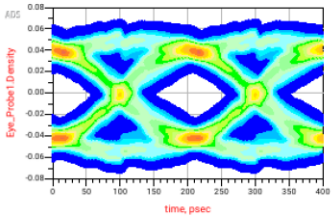


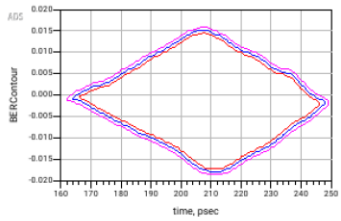

```
taps_quan =

   -0.1429    0.7143   -0.1429
```

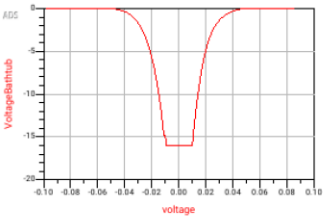
(3 bits resolution)

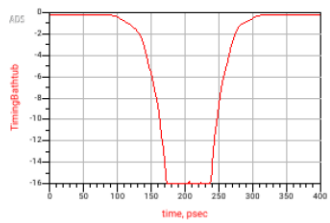
CASE6



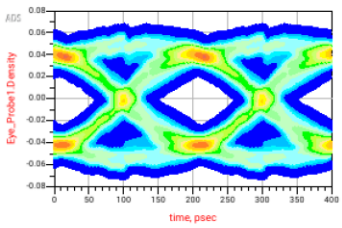


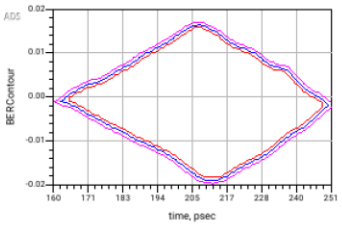
index	...ute(Eye_Probe1.Height)
0.000	0.043





CASE7





index	...ute(Eye_Probe1.Height)
0.000	0.044