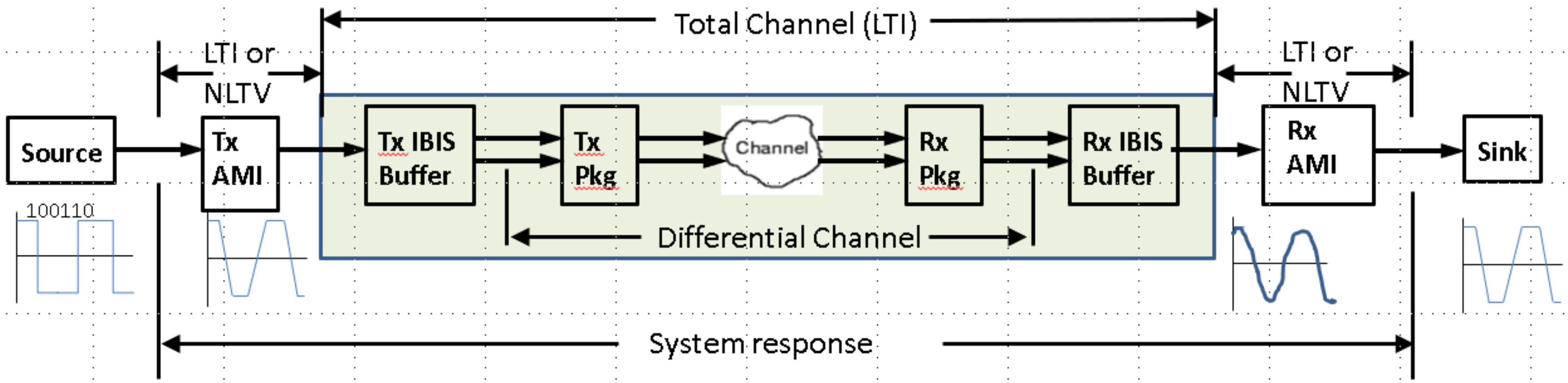
Subject: About the Channel Simulation Tool

Author: John Baprawski; John Baprawski Inc. (JB)

Date: Jan 3, 2019; Rev 5/17/2025

This paper discusses features on the web site: **https://www.serdesdesign.com/**

The Channel Simulation Tool analyzes a channel used with a SerDes system that has a typical structure shown in this figure.



The differential channel often includes a transmit (Tx) package and a receive (Rx) package.

- The differential channel represents a hardware SerDes channel and is typically characterized by measuring its N-port S-parameters and is typically a 4-port. The 4-port differential input ports are typically port 1 (+) and port 3 (-). The associated differential output ports are typically port 2 (+) and port 4 (-). The differential characteristic (Port 1 – Port 3 vs. Port 2 – Port 4) is the channel transmission characteristic and is observed versus frequency.
- See S-parameter detail in References > **S-Parameter Channel Examples**
- The S-parameters may also be obtained from various simulators.

- A high speed digital SerDes channel typically has substantial high frequency attenuation at and beyond the bit/symbol rate Nyquist frequency and requires compensation using equalizers at the transmit and/or receive side of the channel.

The total channel is inclusive of the Tx IBIS Buffer and Rx IBIS Buffer.

- See IBIS Buffer detail in: **IBIS Buffers used in SerDes Simulations**
- The total channel, inclusive of the S-parameters, is converted to an equivalent single ended impulse response.
- See channel impulse response detail in References > **Channel Time-Domain Response**
- The typical approach involves zero-padding the S-parameters for the time domain SampleRate (SampleRate = BitRate * SamplesPerBit) for a maximum frequency of SampleRate/2.0 and applying the constraints for physical realizability which include meeting the mathematical aspects of the Kramers-Kronig relations applied to linear time invariant (LTI) systems. This zero-padding approach often results in high frequency aliasing.
- SerDesDesign.com uses a proprietary algorithm to obtain the causal channel impulse response which inherently does not result in any high frequency aliasing.
- See Causal S-Parameters detail in: **About the Generate Causal S-Parameters Tool**

To use the Channel Simulation Tool, follow the steps on the web page.

1. Define the analysis name

Analysis name: Serdes_	SystemTest		Alpha-numeric characters or underbar - case sensitive - start with alpha character

-
- An alpha-numeric character string; including underbar - case sensitive - start with alpha character.

2. Define the Transmitter jitter

TransmitterJitterType	Transmitter jitter type	0		Integer	[0, 1]	0 = Use Ch0 IBIS-AMI jitter 1 = Apply this jitter

-
- Set to ‘1’ to override the Tx jitter defined with the AMI model.

3. Define the channel including IBIS-AMI.

ChSpec	Channel specification	3		Integer	[3]	3 = Enable main channel (Ch0)

- See detail documentation at: [Channel_wTxRx_IBIS_Pkg]()
- Transmitter can be defined without or with an AMI portion.
    - The AMI portion is defined by referencing the IBS file.
- Channel represent a differential channel:
    - Transmitter IBIS output buffer. See detail: **[IBIS Buffers used in SerDes Simulations]()**
    - Transmitter differential channel packaging S-parameter file with at least 4 ports.
    - Receiver differential channel packaging S-parameter file with at least 4 ports.
    - Receiver IBIS input buffer. See detail: **[IBIS Buffers used in SerDes Simulations]()**
- Any S-parameter file used is automatically adjusted as needed to conform to the physical realizability constraints of passivity, reciprocity, and causality, as well as reduction of noise in the S-parameters.

4. Define the Receiver jitter

ReceiverJitterType	Receiver jitter type	0		Integer	[0, 1]	0 = Use Ch0 IBIS-AMI jitter 1 = Apply ths jitter

- Set to ‘1’ to override the Rx jitter defined with the AMI model.

5. Setup the analysis.

SymbolRate	Symbol rate (same as bit rate for NRZ)	2.50E+10		Real	> 0	Symbols per second (same as bits per second for NRZ)
SamplesPerSymbol	Samples per symbol (same as samples per bit for NRZ)	32		Integer	[4, 128]	
SetupOptions	Setup analysis options	1		Integer	[1]	0 = No 1 = Yes

- Define the bit (symbol) rate in bits (symbols) per second.
- Define the number of samples per bit (symbol).
- Set SetupOptions = 1 to ‘Open’ its dialog box.
- See detail documentation at: **Setup Options**
- Note: Set ForceBitByBitMode =1 to force Bit-by-Bit simulation model when the SerDes system is LTI.

4. Run the analysis.

Select to run analysis	Run

5. Display results.

Analysis log file	Open
0. Channel spectrum magnitude	Open
1. Channel spectrum phase	Open
2. Channel data impulse response	Open
3. Corrected channel impulse response	Open
4. System worst/best case eye contours	Open
5. System amplitude bathtub BER	Open
6. System Rx input waveform	Open
7. System Rx output waveform	Open

- Observe the channel frequency domain characteristic, its equivalent impulse response, its eye diagram, and its BER bathtub curve.
- See detail: **Typical Channel Simulation Characteristics and Displays**
- After the Analysis is Run, the Analysis Log file is displayed.
- Look at the bottom of the file to see that the analysis was successful.

  Go to the Eye Analysis Tool for detail eye analysis for this SerDes system (set ChAnalysisName = Serdes_SystemTest).
  Exiting SerDes System Analysis with success; run time = 17 sec.

6. Open the Eye Analysis Tool to observe the detail eye analysis results.

- Fill in the ChAnalysisName to be the same name used in the Channel Simulation Tool.

ChAnalysisName	Channel analysis name	Serdes_SystemTest

- See detail discussion at: About_the_Eye_Analysis_Tool
- These displays are available:

1. System eye worst/best case contours; no additional applied jitter	Open
2. Applied jitter PDF	Open
3. System eye amplitude PDF	Open
4. System eye timing PDF	Open
5. System eye density plot	Open
6. System eye amplitude bathtub BER	Open
7. System eye timing bathtub BER	Open
8. System BER vs eye height	Open
9. System BER vs eye width	Open
10. System constant BER eye contours	Open

-

Terms & Conditions | Privacy Policy