Subject: About the Channel Analysis Tool

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

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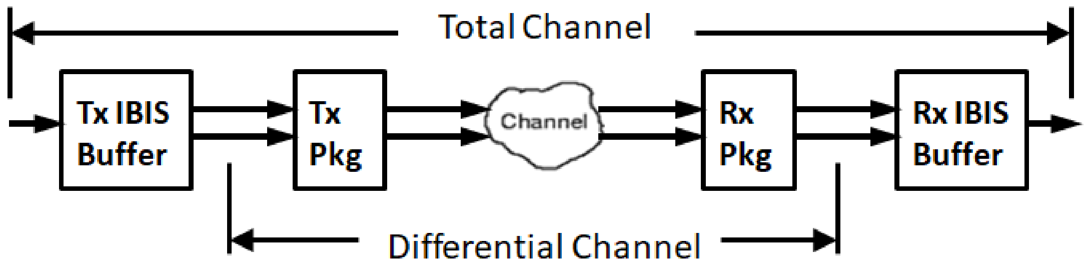
This paper discusses features on the web site: **https://www.serdesdesign.com/**

The Channel Analysis 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 Analysis Tool, follow the steps on the web page.

1. Define the analysis name

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

2. Define the channel.

    - The channel is considered to be LTI and can be defined in a number of different ways.
        - ChannelType = 0; no channel is included
        - ChannelType = 1; channel is defined with impulse response data file with *.csv (comma separated variables) format with two columns. First column is for time (with constant time step) and second column is for impulse value. The time data must start with zero and have constant time step equal to the sampling interval (= 1/SampleRate = 1/BitRate/SamplesPerBit).
        - ChannelType = 2; channel is defined with an S-parameter file with at least 4 ports that represent a differential channel.
        - ChannelType = 3; channel is defined with an S-parameter file with at least 4 ports that represent a differential channel pulse options for:
            - 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.
- See detail: **Define Channel**

3. Setup the analysis.

- Define the bit (symbol) rate in bits (symbols) per second.
- Define the number of samples per bit (symbol).
- Set up analysis options: **Setup Options**

4. Run the analysis.

5. Display results.

- Observe the channel frequency domain characteristic, its equivalent impulse response, its eye diagram, and its BER bathtub curve.
- See detail: **Typical Channel Characteristics and Displays**

6. Download the causal channel data files.

- Download the total channel causal impulse response. Use this file in other tools to speed up their analysis without duplicating the work (time) to convert the channel into its causal impulse response.
    - For example, for detail SerDes system analysis, including jitter and BER analysis, use the causal impulse response in the **SerDes System Signal Channel Tool** 'Define Channel' section.
- Download the differential band limited 4 port S-parameters for the differential channel.
    - This is based on interpolation of the differential channel S-parameter files to achieve a response from 0 Hz to the maximum common frequency in the S-parameter files with a constant frequency step.
- Download the differential causal 4 port S-parameters for the differential channel.
    - This is based on interpolation and extrapolation of the differential channel S-parameter files to achieve a response from 0 Hz to half the simulation sample rate (BitRate*SamplesPerBit/2) with a constant frequency step.

- This exported file can be used in other channel simulators to achieve a more reproducible channel impulse response in the other channel simulators.

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:

```
Writing Impulse files.
Writing Spectrum files.
Writing Waveform response files.
Writing System worst/best case eye contour files
Writing BER metric files

Exiting Channel Analysis with success; run time = 14 sec.
```

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