Subject: Typical SerDes System Characteristics and Displays

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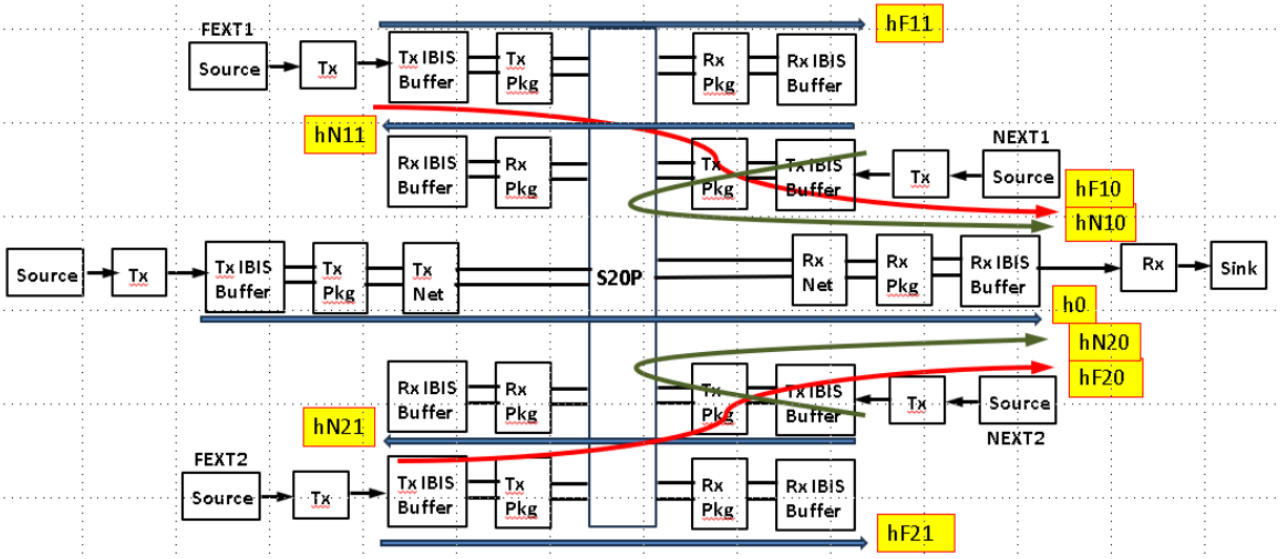
This paper discusses features on the web site: **https://www.serdesdesign.com**

The CrossTalk Simulation Tool analyzes a SerDes system that has a typical structure shown in this figure.



See discussion in '**About the CrossTalk Simulation Tool**'.

Within the above system crosstalk figure, all hxxx responses represent impulse responses inclusive of the channel Tx IBIS buffer through the channel Rx IBIS buffer.

- h0 represents the main channel Tx IBIS Buffer through Rx IBIS Buffer impulse response.
- hF11/hF21 represents the FEXT1/FEXT2 adjacent channel Tx IBIS Buffer through adjacent channel Rx IBIS Buffer impulse response.
- hF10/hF20 represents the FEXT1/FEXT2 adjacent channel Tx IBIS Buffer through main channel Rx IBIS Buffer impulse response impulse.
- hN11/hN21 represents the NEXT1/NEXT2 channel Tx IBIS Buffer through Rx IBIS Buffer impulse response.
- hN10/hF20 represents the NEXT1/NEXT2 channel Tx IBIS Buffer through main channel Rx IBIS Buffer impulse response impulse.

For detail discussion about a SerDes system with no cross talk, see
About_the_CrossTalk_Simulation_Tool.pdf

For detail discussion on typical characteristics and displays for a SerDes system with no cross talk, see **Typical_Channel_Simulation_Characteristics_and_Displays.pdf**

This section only discusses the additional characteristics and displays relevant to crosstalk. Let us know if you would like the tool enhanced with additional capability.

The tool default signaling uses NRZ with 25 Gbps and 32 samples per symbol. PAM is supported along with arbitrary symbol rates and samples per symbol.

The tool default crosstalk coupling S-parameter file (with max freq 0 GHz) used in the tool is: xtalk_5_coupling.s24p

This is used in place of the 'S20' block in the above crosstalk block diagram.

These are the default differential channel port assignments.

- Main channel (Ch0): +in: 5; +out: 6; -in: 7; -out: 8
- FEXT1 channel: +in: 1; +out: 3; -in: 2; -out: 4
- NEXT1 channel: +in: 9; +out: 11; -in: 10; -out: 12
- FEXT2 channel: +in: 13; +out: 15; -in: 14; -out: 16
- NEXT2 channel: +in: 17; +out: 19; -in: 18; -out: 20

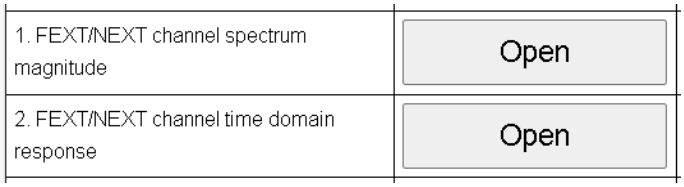
The unused ports are terminated in S-parameter file reference resistance (50 Ohms in this case).

The crosstalk from the FEXT/NEXT channels to the receive side of the main channel is to the main channel +out and -out ports. Thus, these are the crosstalk channels:

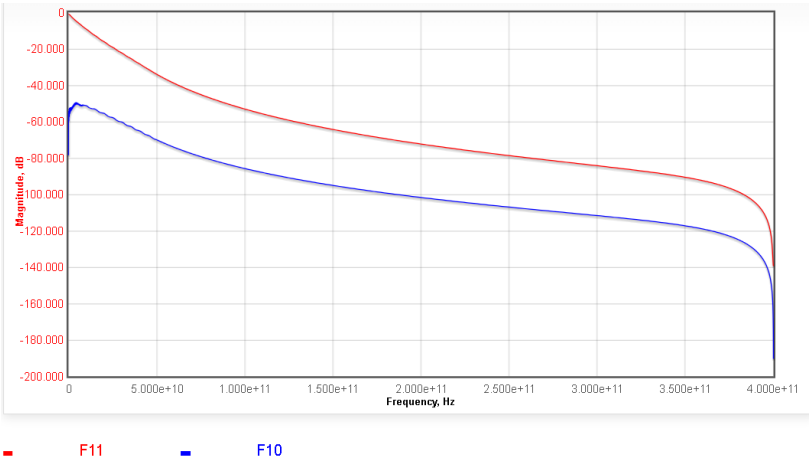
- FEXT1 crosstalk: +in: 1; +out: 6; -in: 2; -out: 8
- NEXT1 crosstalk: +in: 9; +out: 6; -in: 10; -out: 8
- FEXT2 crosstalk: +in: 13; +out: 6; -in: 14; -out: 8
- NEXT2 crosstalk: +in: 17; +out: 6; -in: 18; -out: 8

During simulation, loading from all the channels are included when deriving the total channel responses. For example, the FEXT1 crosstalk is inclusive of the FEXT1 Tx IBIS through the Ch0 Rx IBIS. By default, the tool is setup with ideal Tx/Rx buffers with 50 Ohms per differential pin.

The CrossTalk Tool allows one to view the total crosstalk channel response in the frequency and time domains.



For example, the default total FEXT1 crosstalk channel frequency domain response is shown here:



F11 is for the total FEXT1 channel. F10 is for the total FEXT1 crosstalk channel.

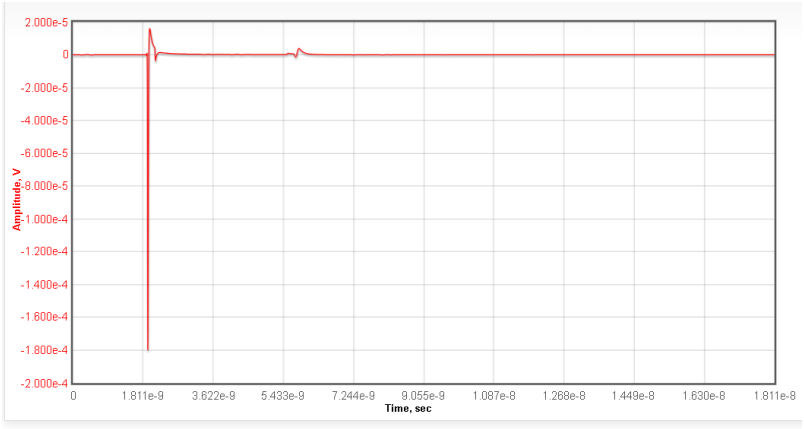
Though the S-parameters are up to 50 GHz, the S-parameter to time domain conversion uses a SampleRate = SymbolRate*SamplesPerSymbol with upper frequency SampleRate/2 (400 GHz in this case). Above 50 GHz, there is no high frequency aliasing due to the SerDesDesign.com processed discussed in other documents.

Similar frequency domain plots are available for FEXT2, NEXT1 and NEXT2.

The time domain plots for the total crosstalk channels are available as impulse responses, step responses, and pulse responses by setting the SetupOptions XTalkDisplayType:

XTalkDisplayType	FEXT/NEXT channel time domain display type	0		Integer	[0, 2]	0 = Impulse 1 = Step 2 = Pulse

For the default Impulse setting, the default total FEXT1 crosstalk channel time domain response is shown here:



Only F10 is displayed. The F11 total FEXT1 channel time domain response is not shown.

This time domain response is an accurate representation with the defined SampleRate even though the S-parameters maximum frequency is only 50 GHz.

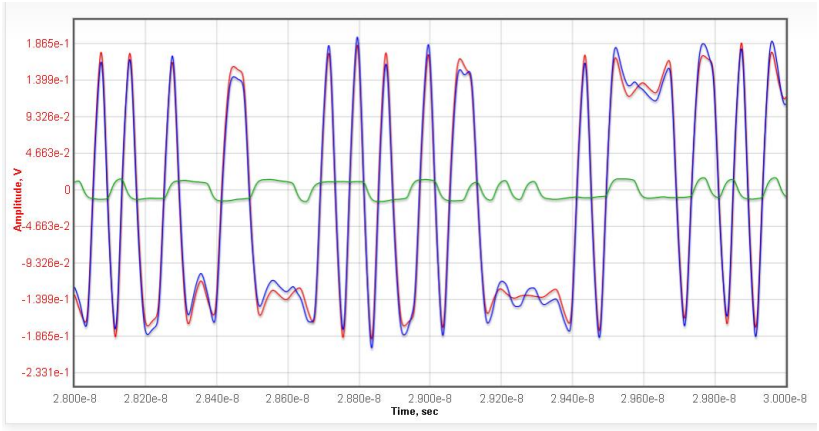
Similar time-domain plots are available for FEXT2, NEXT1 and NEXT2.

Additional time domain waveforms associated with the crosstalk are available at the main channel Rx AMI input.

For example:

- Set the FEXT1 channel to have an NRZ pattern uncorrelated from that used in the main Ch0 channel.
- Use the Tx/Rx IBIS-AMI models included with the CrossTalk Tool (TxFFE and RxFFE_CDR_DFE) for the main Ch0 channel and the FEXT1 channel.
- For demonstration of crosstalk, the FEXT1 signal has an additional gain of 10.

The waveforms at the main Ch0 channel Rx AMI input are shown here.

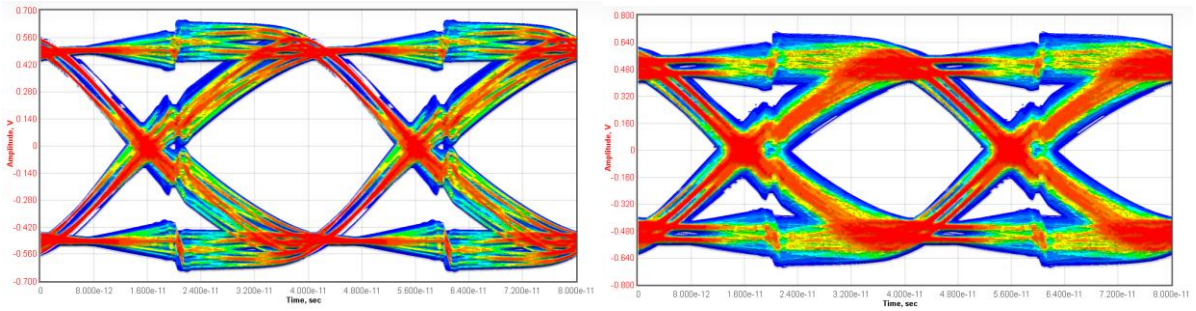


RxIn is from the main channel. aF10 is the crosstalk from the FEXT1 channel. RxInWithA is the combined waveform into the main channel Rx AMI model.

The other data displays in the Channel Simulator Tool are also available in this CrossTalk Tool.

For detail channel eye analysis, including jitter and BER characteristics, use the Eye Analysis Tool after analyzing a channel.

Here is the detail Eye Density Plot without cross talk (left) and with cross talk (right).



The red color implies greater density. The blue color implies lower density.