

TDR Simulations: How to compare FEM and transient simulation results.

Problem/Description:

TDR results may be simulated using HFSS FEM and HFSS Transient solvers. Both methods can be used to achieve accurate and efficient results. When comparing the results, it is important to align TDR results from both simulations in time. If left all settings to the default, the results of transient simulations seem delayed compared to results of FEM simulations.

Solution:

After solving broadband frequency sweep using HFSS FEM solver, it is possible to plot TDRZt function using TDR options settings. Among this setting, there is rise time for step input function. The detailed description of steps is available in on-line Help. Rise time equal to zero is also allowed and results in valuable information. Fig. 1 features TDR curves for zero and 50ps rise time. Note that offset time for both curves corresponds to the path to the first reflection and back.

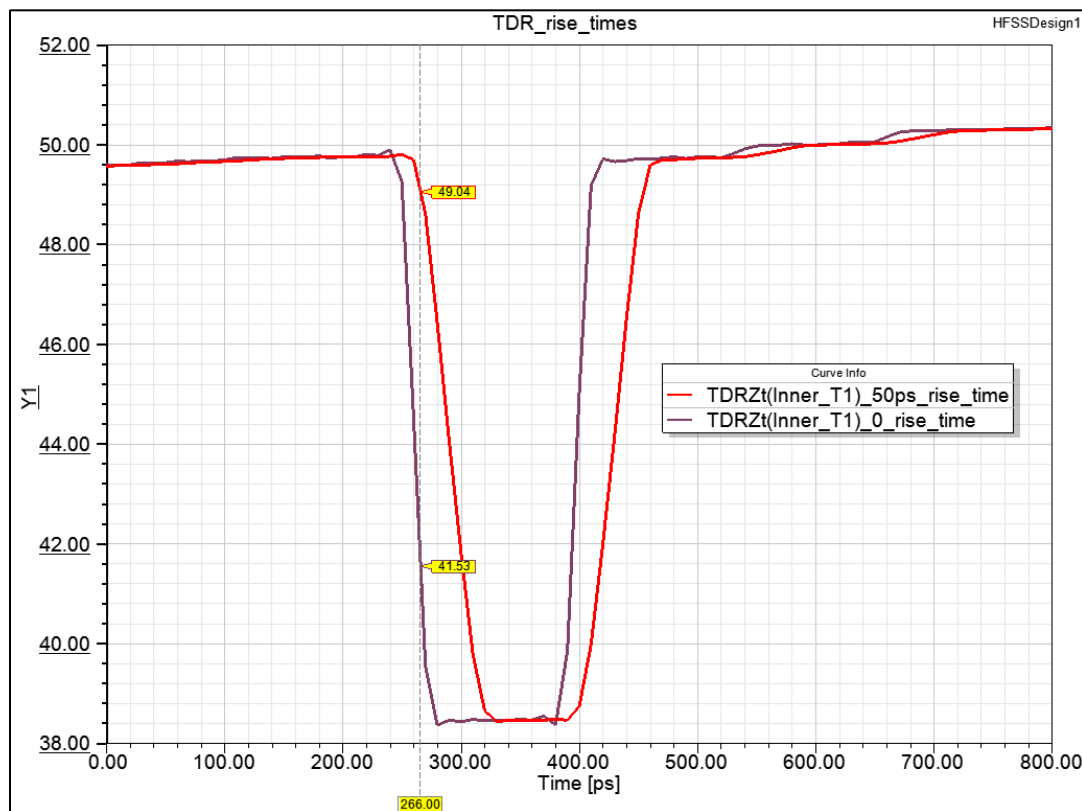


Figure 1: TDR plot of FEM solution: black line corresponds to 0 rise time option and red line corresponds to 50 ps rise time of input step function.

When assigning input step signal for transient simulation as illustrated in Fig. 2, there is an option to assign not only the rise time but also TDR midpoint. This setting controls the delay of the input signal and has a minimum value. The default option, checked “Sync” button, automatically sets this delay time. This way, when plotted with default settings, the results of FEM and transient TDR analysis always have some time offset. To align the results, it is necessary to plot FEM TDR using shifted time axis. Time offset is calculated as TDR midpoint – 0.5 RiseTime. For example, for TDR midpoint=200ps and RiseTime=50ps, the time offset should be 175ps as shown in Figure 4. Then the TDR curves are aligned as illustrated in Figure 5. The difference can be explained by the accuracy of simulations and approximations involved in TDR calculations based on frequency domain data.

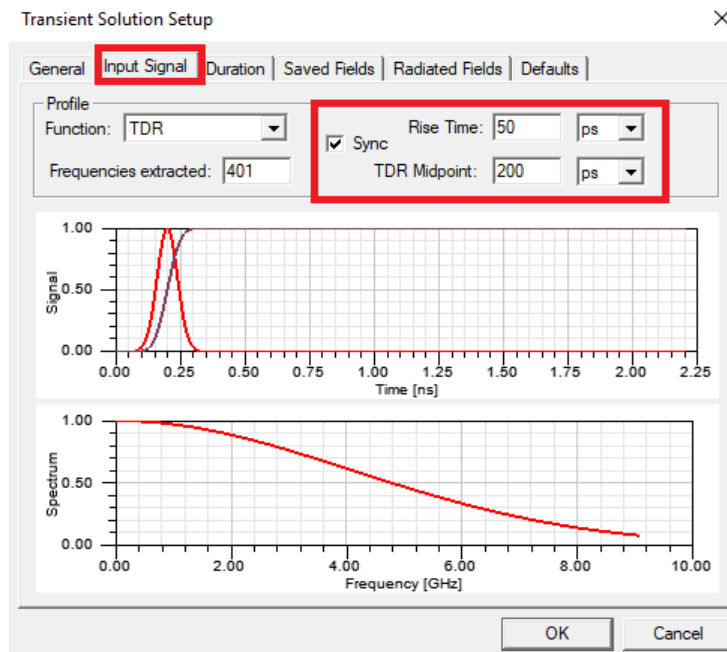


Figure 2: Input Signal settings in Transient Solution Setup

TDR	Rise Time	This resembles a Sweep with a Min Freq. of 0 Hz. For convenience, however, this time profile is specified by the rise time rather than the frequency range. This also enables TDR output.
	Frequencies extracted	The rise time is defined as from 10% to 90% of the peak signal value
	TDR Midpoint	TDR Midpoint is the time where the input TDR signal is at 50 % of the peak value.
	Sync	The Sync check box lets you automatically synchronize the signal midpoint and rise time such that minimum allowed midpoint is used for a given rise time or the maximum rise time for a given midpoint. If you leave the box unchecked, you can specify a different delay. If the delay is not valid, the dialog does not close, and you are prompted to provide a value.

Figure 3: Options for input signal of transient simulations as described in on-line Help

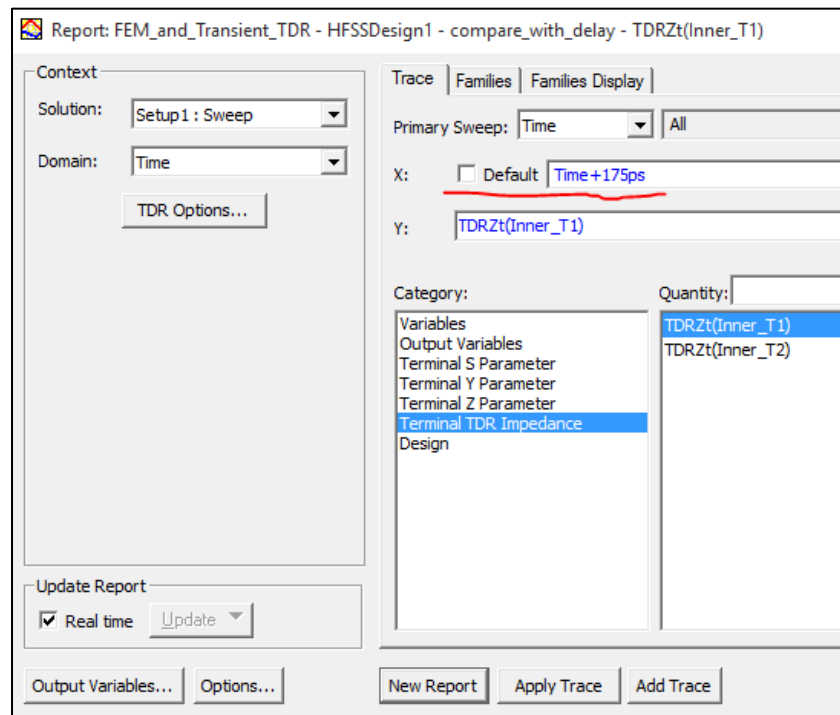


Figure 4: Plot setup to align the results of FEM and transient TDR analysis

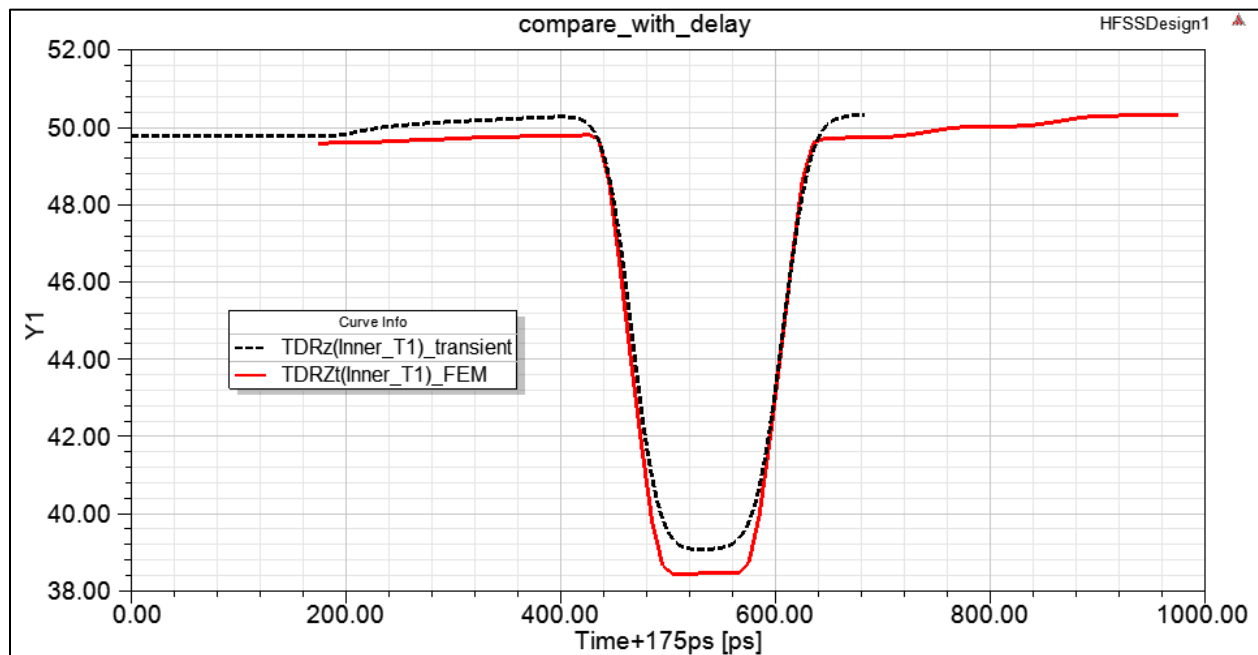


Figure 5: Aligned results of FEM and transient TDR analysis