This section presents differential and single-ended versions of a Time Domain Reflectometer (TDR). The setup demonstrates the process of analyzing both imdepance and delay. The schematics are configured so that you can substitute another design for the Device Under test, then run the analysis and view the results.

The topics for this section include:

Analysis with the Single-Ended TDR

Analysis with the Differential TDR

Single-Ended TDR

The schematics for both single-ended and differential TDRs are in one project in the Examples directory.

MS Windows® systems only: Load and open the TDR project in Designer by clicking the link below.

- 1. An Active X control message may appear. Respond "Yes" to continue.
- 2. A message window appears to confirm that the project has been loaded. Click **OK** to close the message, and then if necessary click the **BACK** arrow at the top left of the Help window to return to the Getting Started topic.
- Load the Example

All systems: Open the TDR Schematic project from its file in the Examples directory.

- 1. On the File menu, select Open. The File Open window appears.
- 2. Click on the **Examples** directory, then the directory **Nexxim Circuit**, then select the file **TDR_Example.adsn**. Click **Open**.



Expand the TDR_Example icon and the Single Ended icon. The single-ended TDR schematic appears in the design window:

The single-ended TDR consists of a unit pulse source, a 50-ohm reference impedance, a reference length of transmission line (50 ohm impedance, 0.5ns delay), and two voltage probes, Vexcited_pos for the step voltage and Vdetected_pos for the reflected voltage.

The Device Under Test (DUT) is a series of transmission lines and discrete passives to represent the typical TDR problem of finding where impedance changes in a line.

In sequence, the DUT elements are:

- Transmission line, 50-ohm impedance, 1ns delay.
- Shunt capacitor, 1pf.
- Transmission line, 50-ohm impedance, 3ns delay.
- Transmission line, 55-ohm impedance, 5ns delay.
- Series inductor, 5nH.
- Series resistor, 1gigohm.
- Terminating ground.

4 - 98 Nexxim Circuit Design

3. Expand the Analysis icon and double-click on the Transient analysis setup.

Transient Analysis					
Name: Tran	nsient 🗌 🗌 🛛	Disable			
- Analysis Contr	ol				
Step	0.1	ps 💌			
Stop	25	ns 💌			
Accuracy	default	•			

4. Left-click on the Transient analysis icon and select **Analyze**. The analysis runs to completion.

Nexxim Circuit Design 4 - 99

5. Expand the Reports icon and right-click on the **Zload** report setup. Select **Modify Report** to open the Report Setup.

🔀 Report: TDR_example - Single Ended - Zload - O(A113:zl) 🛛 🛛 🔀				
Context Solution: Transient	Trace Families Families Display			
Domain: Time	X: Image: Comparent state			
Plotting Range Windowing C Thinning Time Start: 0 ps v Time Start: 25	Y: O(A113:zl) Range Function			
	Variables O(A113:2l) <none> A Output Var Voltage Current acos</none>			
Update Report Real time	Power Device Pro Measure			
Output Variables Options	New Report Apply Trace Add Trace Close			

4 - 100 Nexxim Circuit Design



6. Click **New Report** to generate the report:

The TDR analysis allows us to identify each of the components of the DUT by their timing and behavior.

- At 3ns, the impedance drops to indicate the presence of the capacitor. The 3ns delay is the TDR internal delay (0.5ns) plus the first transmission line delay (1ns), times two for the reflection. Both transmission lines are at 50 ohms.
- At 9ns, the impedance increases to 55 ohm at the beginning of the 55-ohm line segment. 9ns=2(0.5+1.0+3.0).
- At 19ns, the impedance jumps to indicate the presence of the inductor, then immediately drops to 25 ohm for the resistor. 19ns=2((0.5+1.0+3.0+5.0).
- At 23ns, the impedance goes to infinity at the high final resistor. 23ns=2(0.5+0.1+3.0+5.0+2.0).

Nexxim Circuit Design 4 - 101

Differential TDR

Expand the **TDR_Example** icon and the **Differential** icon. The differential TDR schematic appears in the design window:



The differential TDR consists of two channels, each with a unit pulse source, a 50ohm reference impedance, a reference length of transmission line (50 ohm impedance, 0.5ns delay), and two voltage probes, Vexcited_pos or Vexcited_neg for the step voltage and Vdetected pos or Vdetected neg for the reflected voltage.

The Device Under Test (DUT) is microstrip coupled line pair and a termination network. The transient analysis sweeps the spacing between the coupled lines, so that we can how that spacing affects the differential impedance, Zdiff.

7. Select the coupled lines. The Property window shows that the spacing parameter SP has been defined with a local variable.

Properties					
	Name	Value	Unit	Evaluated Value	^
	W	1	mm	1mm	
	Р	500	mm	500mm	
	SP	spacing		1mm	
					~
Param Values General Symbol					

4 - 102 Nexxim Circuit Design

 Expand the Analysis icon, double-click on the Transient analysis setup, and verify the sweep of the spacing variable.

Transient Analysis					
Name: Transient 🗖 Disable	– Sweep Variable	95			
- Analusis Control	Name	Sweep/Value			
Step 1 ps 💌	spacing	LINC 0.4mm 0.8mm 5			
Stop 10 ns 💌					
Accuracy default					
Output Quantities	1				
Edit	Add	Remove Edit			

9. Left-click on the Transient analysis icon and select Analyze. The analysis runs to completion.

10. Expand the Reports icon and right-click on the **Zdiff** report setup. Select **Modify Report** to open the Report Setup.

🔀 Report: TDR_example - Differentia	- Zdiff - O(A124:zdiff) 🛛 🔀
Context	Trace Families Families Display
Solution: Transient	Primary Sweep: Time All
Domain: Time	X: 🔽 Default Time 🛄
Plotting Range Windowing Thinning Time Start:	Y: O(A124:zdiff) Range Function
Update Report	Category: Quantity: filte Function: Variables OLA124:2diff) Output Var Voltage Current Power Device Pro Measure V
Output Variables Options	New Report Apply Trace Add Trace Close

4 - 104 Nexxim Circuit Design



11. Click New Report to generate the report:

The TDR analysis shows how the spacing affects the differential impedance.