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## Time Domain Reflectometer Example

This section presents differential and single-ended versions of a Time Domain Reflectometer (TDR). The setup demonstrates the process of analyzing both impedance 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.

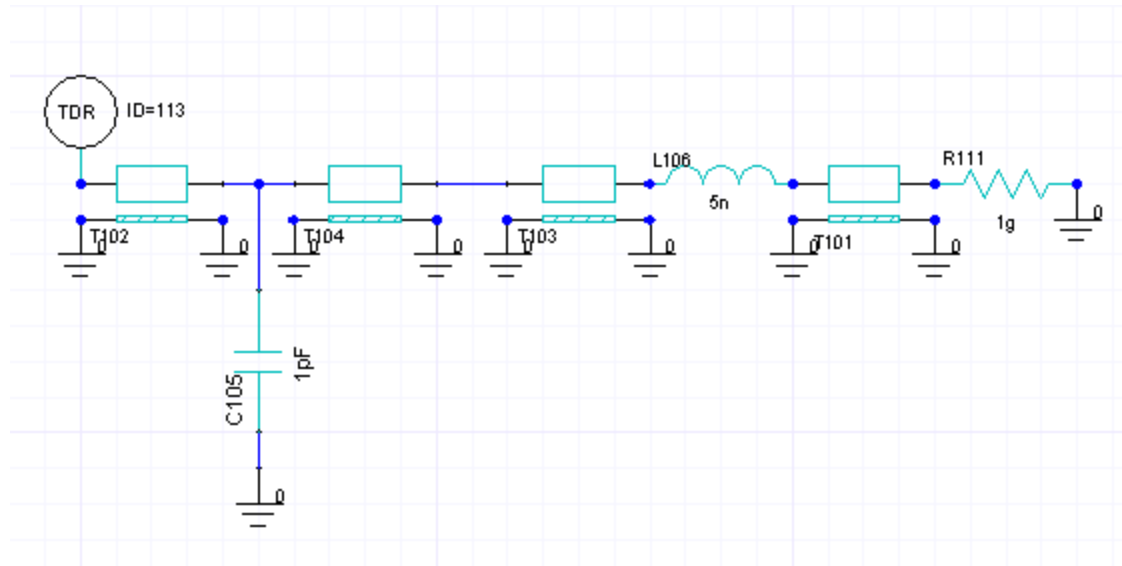
- [Load the Example](#)

**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**.

### Time Domain Reflectometer Example

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.

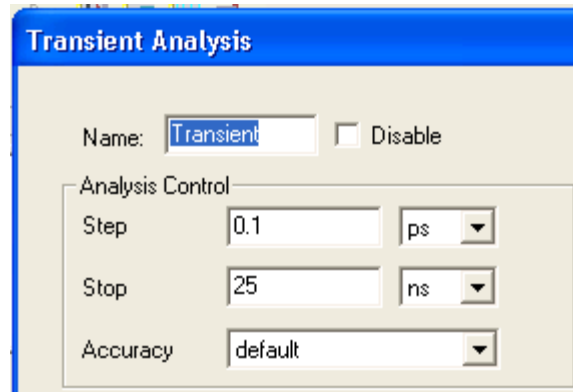
The Device Under Test (DUT) is a series of transmission lines and discrete passives to represent the typical TDR problem of finding where impedance changes in a line.

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.

### Time Domain Reflectometer Example

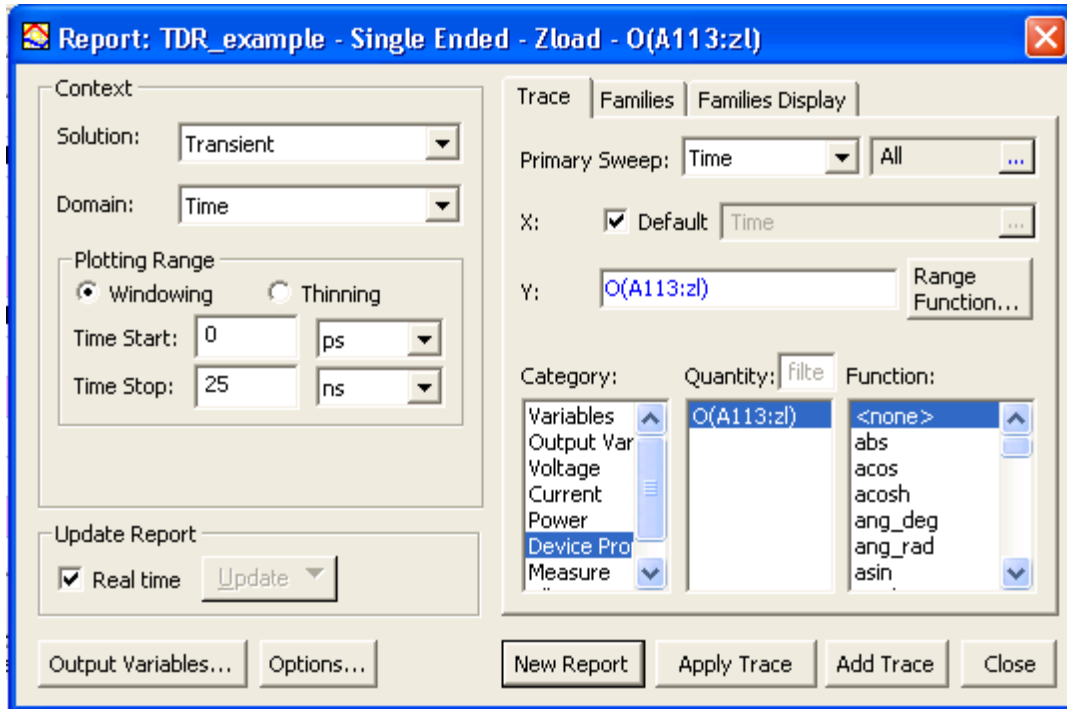
- Expand the Analysis icon and double-click on the Transient analysis setup.



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

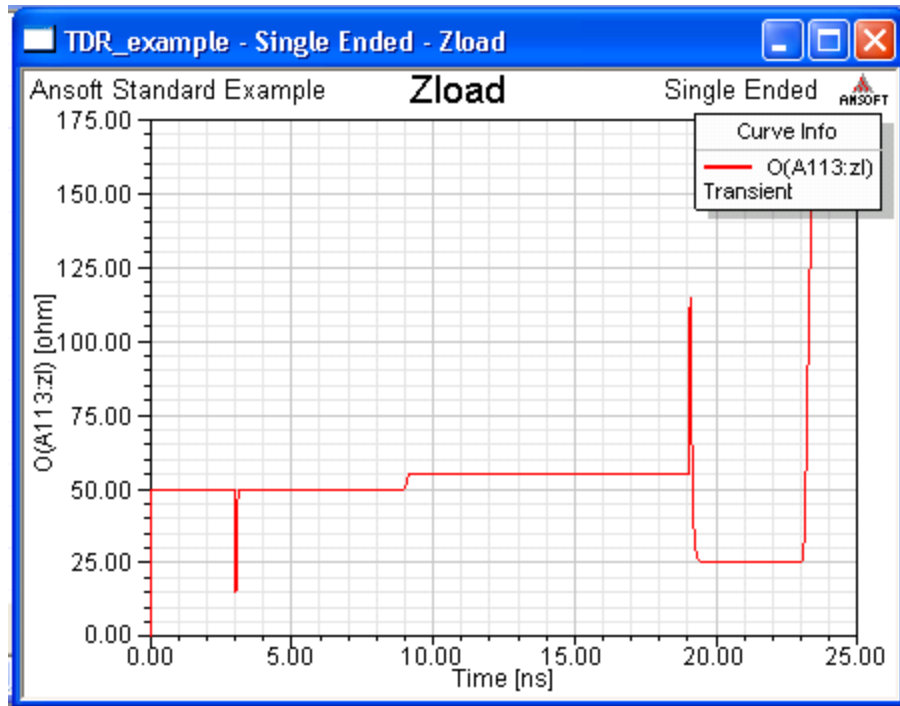
### Time Domain Reflectometer Example

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



## Time Domain Reflectometer Example

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



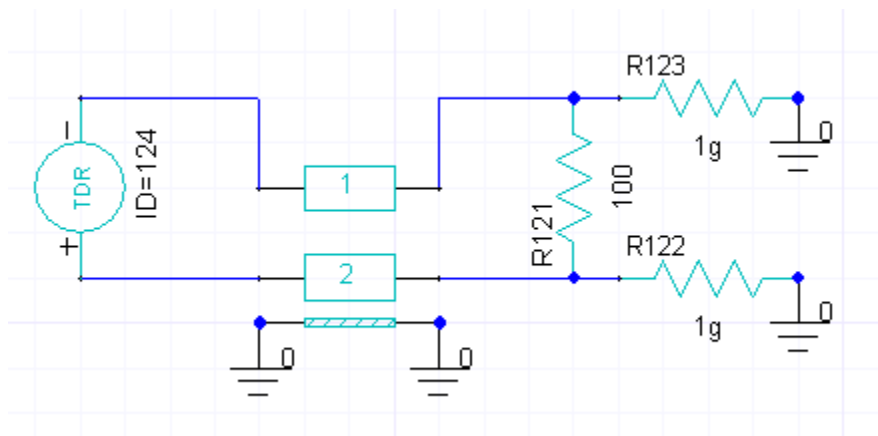
The TDR analysis allows us to identify each of the components of the DUT by their timing and behavior.

- 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.  $9\text{ns}=2(0.5+1.0+3.0)$ .
- At 19ns, the impedance jumps to indicate the presence of the inductor, then immediately drops to 25 ohm for the resistor.  $19\text{ns}=2((0.5+1.0+3.0+5.0))$ .
- At 23ns, the impedance goes to infinity at the high final resistor.  $23\text{ns}=2(0.5+0.1+3.0+5.0+2.0)$ .

## Time Domain Reflectometer Example

### Differential TDR

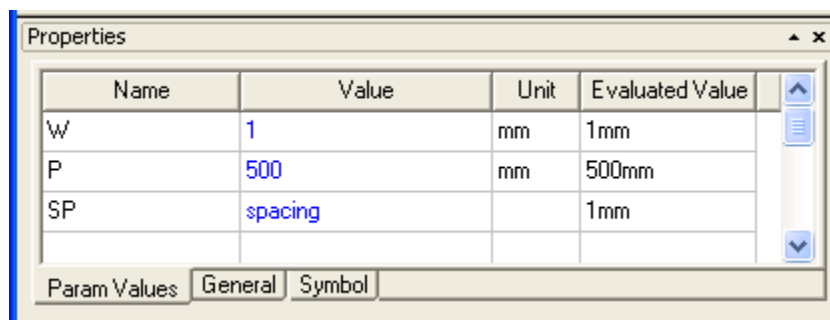
Expand the **TDR\_Example** icon and the **Differential** icon. The differential TDR schematic appears in the design window:



The differential TDR consists of two channels, each with a unit pulse source, a 50-ohm 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.

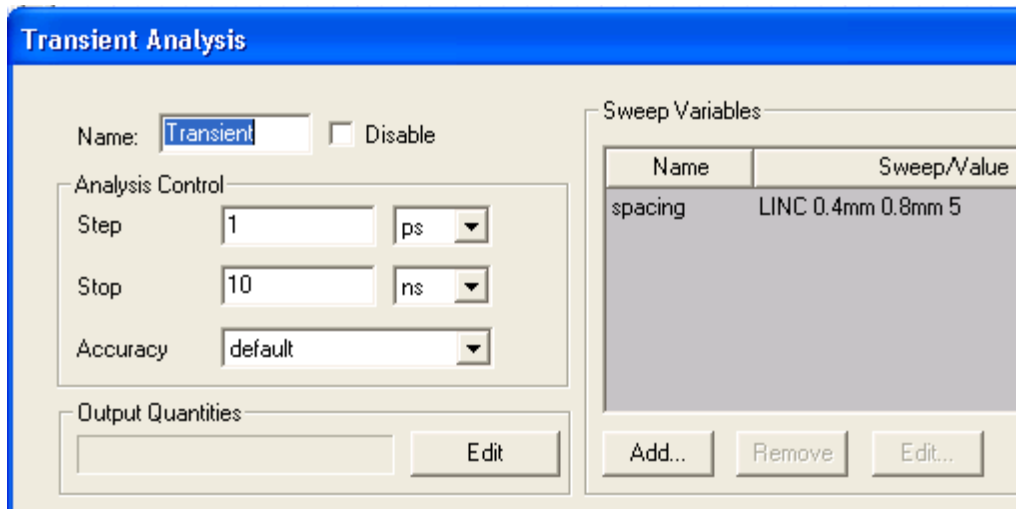
The Device Under Test (DUT) is microstrip coupled line pair and a termination network. The transient analysis sweeps the spacing between the coupled lines, so that we can how thae spacing affects the differential impedance, Zdiff.

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



### Time Domain Reflectometer Example

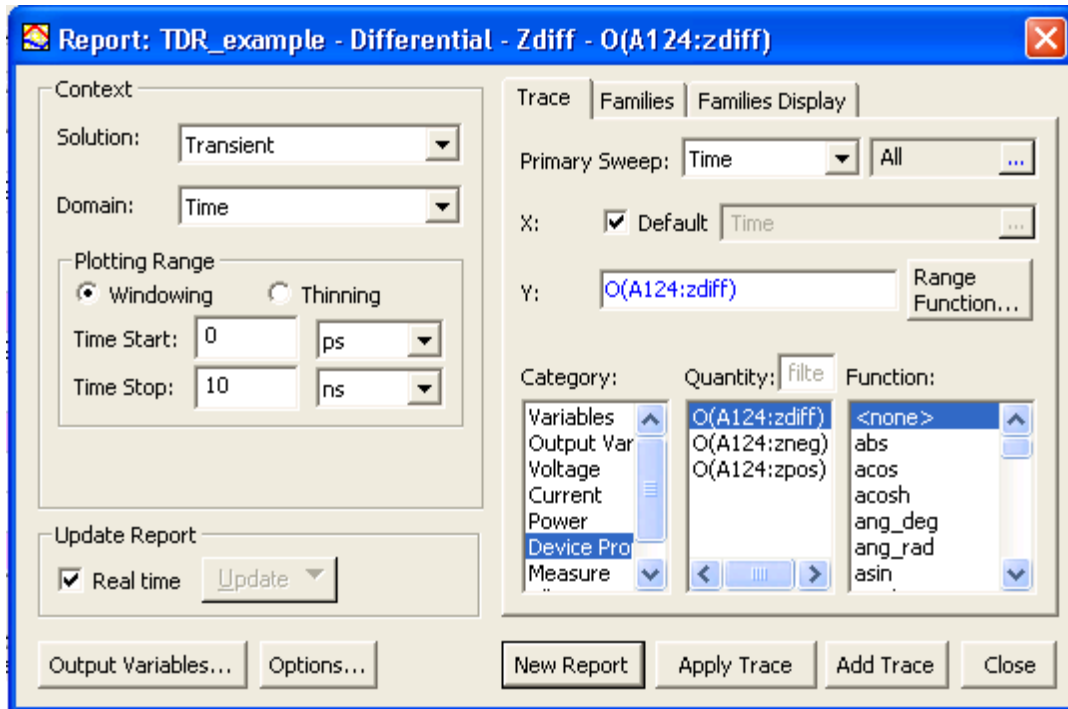
- Expand the Analysis icon, double-click on the Transient analysis setup, and verify the sweep of the spacing variable.



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

### Time Domain Reflectometer Example

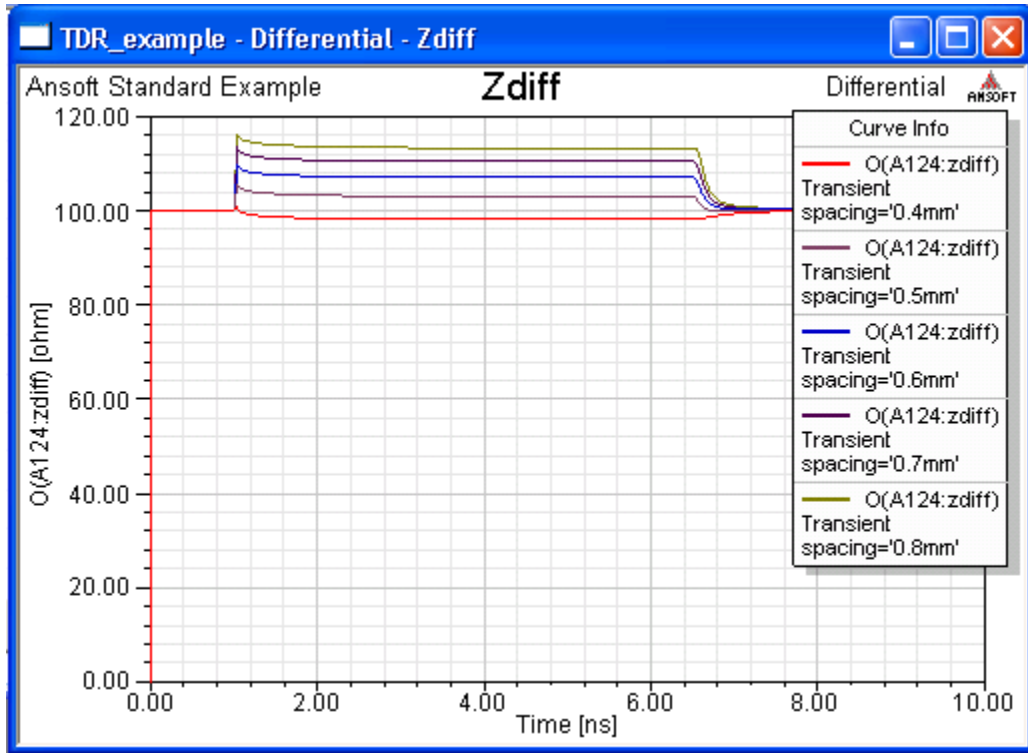
10. Expand the Reports icon and right-click on the **Zdiff** report setup. Select **Modify Report** to open the Report Setup.





### Time Domain Reflectometer Example

11. Click New Report to generate the report:



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