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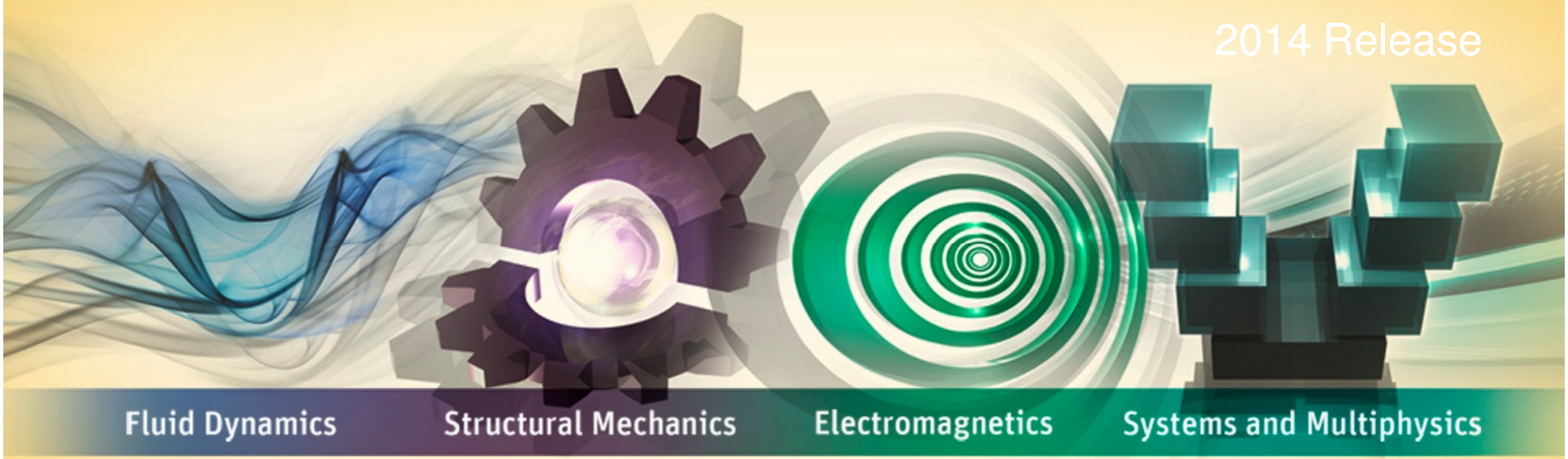
# Workshop 3: Q3D 2D Extractor – Transmission Line Toolkit

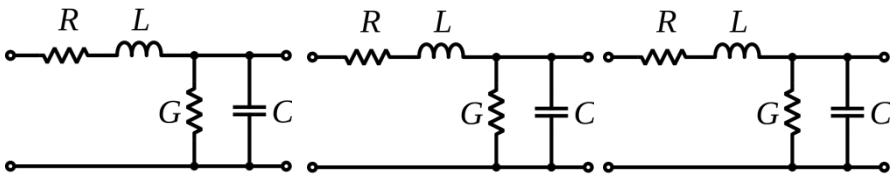



## Stripline Transmission Line 2D Extractor Simulation

# Table of Contents

- **2D Extractor Topics to be Covered:**
  - Creating a  cross-section of stripline Tx line using Transmission Line Toolkit
  - Defining the solution setup
  - Analyzing the model
  - Exporting a W-element model.
- **2D Extractor Overview**
  - The ANSYS 2D Extractor is an electromagnetic field solver that extracts transmission line parameters from the two-dimensional cross-section of an arbitrary multi-conductor transmission line.  Two separate field solvers are applied to extract the parameters necessary to create the transmission line model.
    - **Electrostatic Solver:** Given the voltage applied on the conductors, the electrostatic solver calculates charge on all conductors. The capacitance and conductance per unit length are derived from the electrostatic field solution.
    - **Magnetostatic Solver:** Given the current injected into a conductor, the magnetostatic solver calculates the magnetic flux intersecting all conductors. The inductance and resistance per unit length are derived from the magnetostatic field solution.
  - Most transmission lines used for high speed signaling are comprised of two or more parallel conductors.  If the conductors are close together, the transmission lines can be characterized in terms of frequency dependent R (resistance), L (inductance), C (capacitance), G (conductance) matrices.  This condition must be satisfied in order for the solution from the 2D extractor to be valid.
  - A widely used model for transmission lines is the *W-element* model, which is a table listing the frequency dependence of these RLCG parameters.

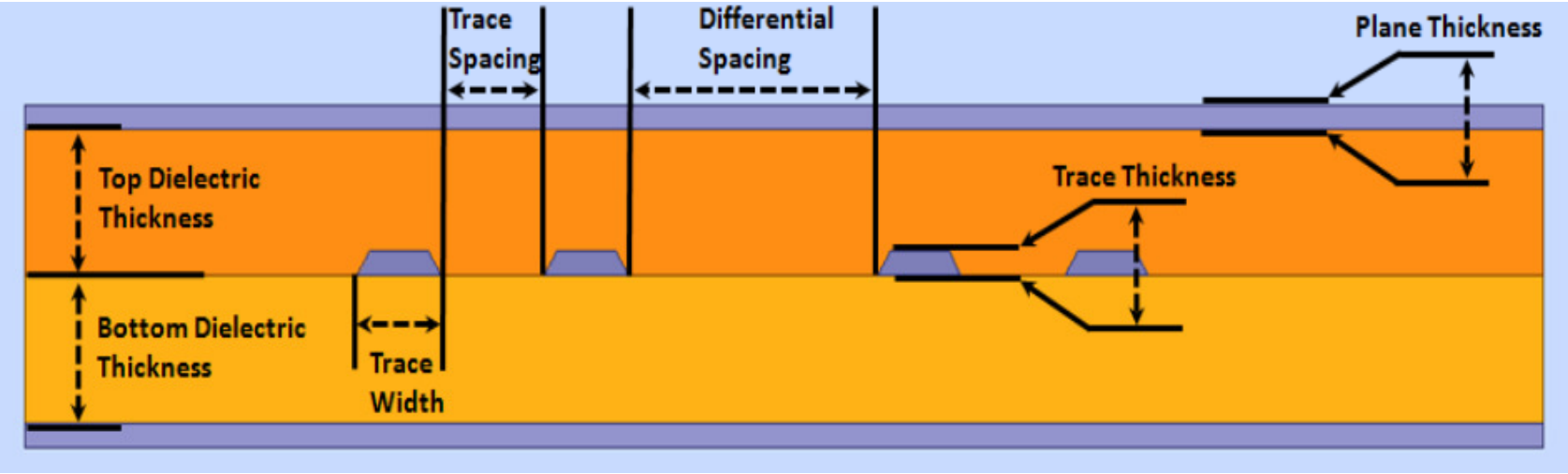
Here is a cascaded RLCG model approximating a two conductor transmission line.  RLCG generally depend on frequency.



# Model Description

- **Transmission Line Toolkit**
  - We will be using the Toolkit to create the 2D geometry and setting up the simulation parameter for the 2D Parameter extractor to solve. The toolkit can also be used to get quick Zo and Zdiff parameters analytically.
- **Differential Stripline**
  - This example demonstrates how to set up and analyze a differential stripline transmission line as shown below.
  - This example will also teach you how to export a frequency-dependent tabular W-element for use with a transient circuit simulator.




**Plane Thickness = 2mils, Trace Thickness = 2mil, Trace Width = 5mil**
**Trace Spacing = 5mil, Bottom Dielectric = 7 mil, Top Dielectric = 7mils**
**Differential Spacing = 15mil**

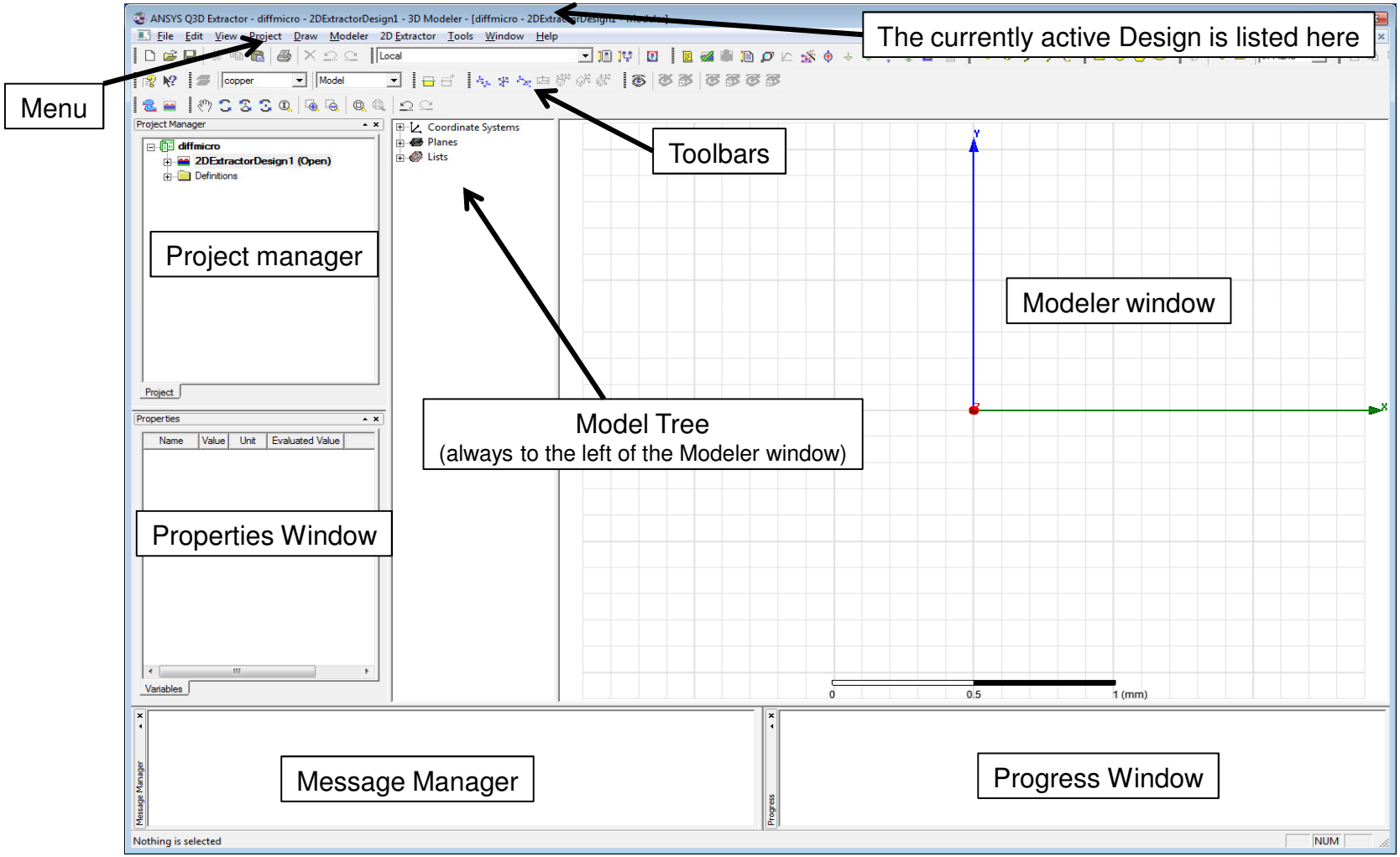
# 2D Extractor

- **Launch Q3D Extractor**
  - The 2D Extractor is part of the product Q3D Extractor (or Q3D), which encompasses both a three-dimensional and a two-dimensional quasi-static field solver. The following exercise focuses entirely on the 2D Extractor portion of the Q3D and the Transmission Line Toolkit.
  - Launching Q3D: To access the Q3D Extractor, click the Microsoft Start button and select

***All Programs > ANSYS Electromagnetics Suite 15.0 > Windows 64 bit > Ansys Q3D Extractor***

# 2D Extractor User Interface

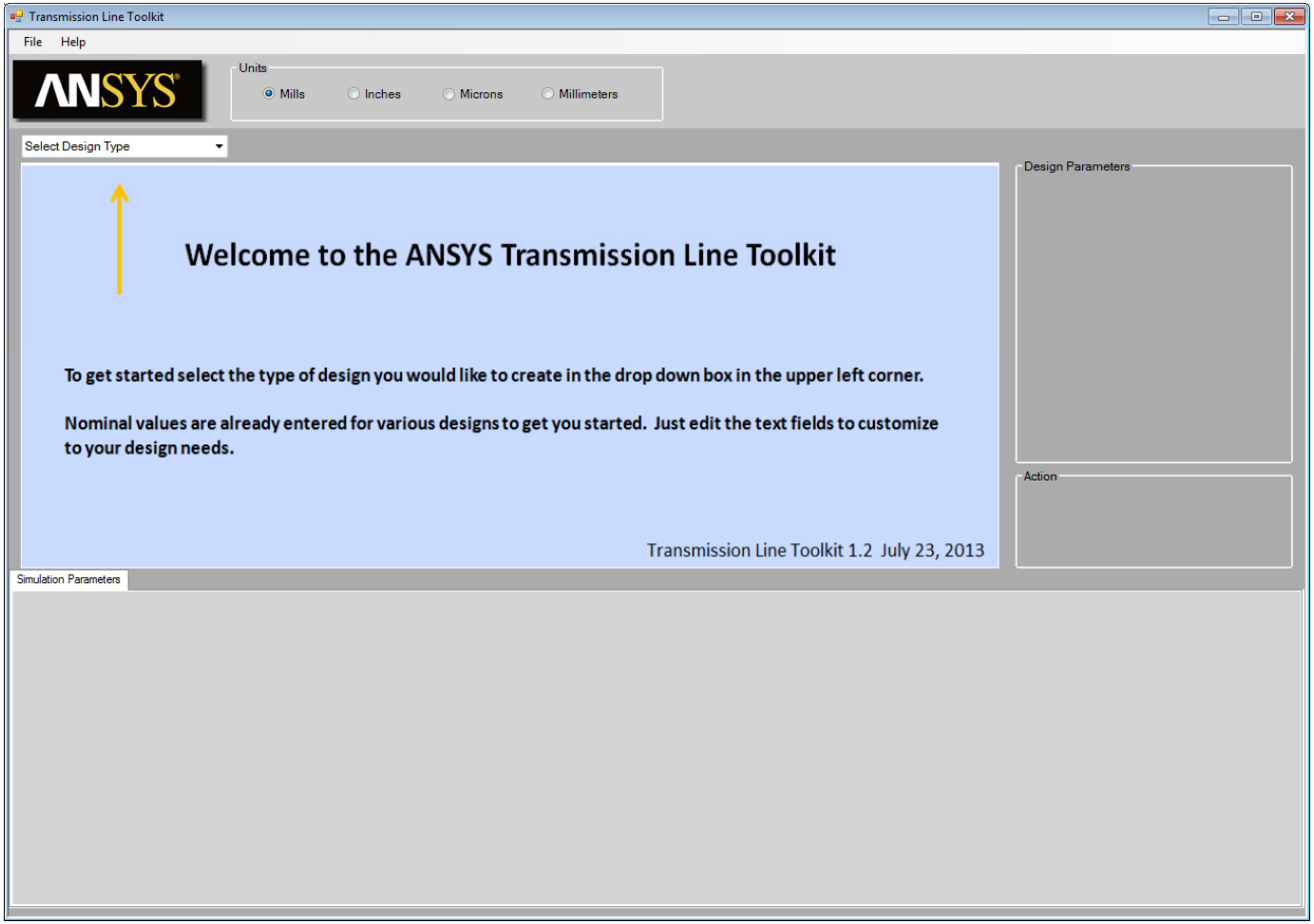
- **Insert a 2D Extractor Design**
  - From the menu select ***Project > Insert 2D Extractor Design***. A 2-D modeling window will appear as shown below.
  - Save the file. From the menu select ***File > Save***. Name the project **diffstrip**



# Transmission Line Tool Kit

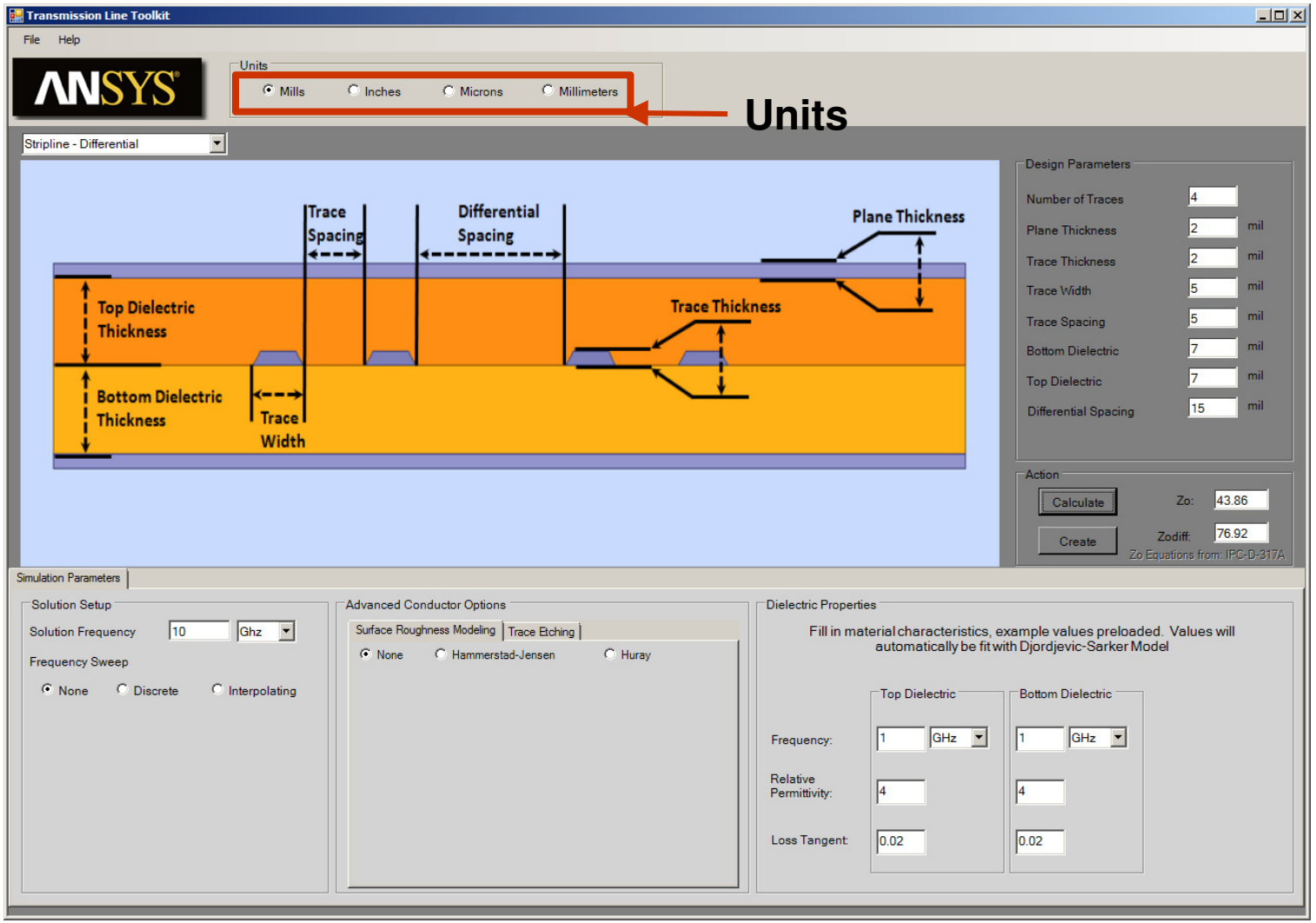
- **Launch Transmission Line Toolkit**
  - From the Menu select **2D Extractor > TransmissionLine Toolkit > T_line Toolkit** A Transmission Line Toolkit modeling window will appear.



# Transmission Line Tool Kit

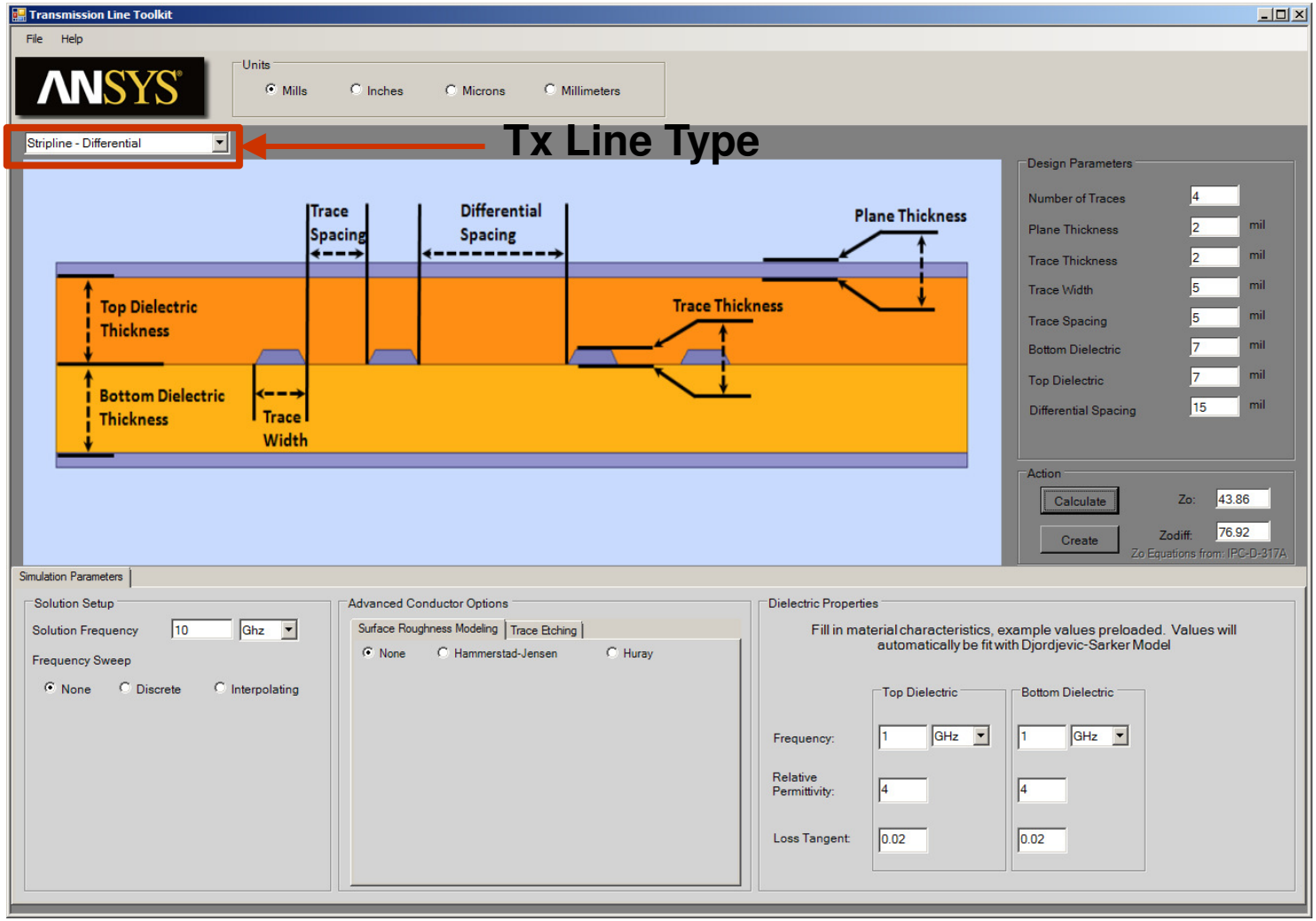
- **Setup Transmission Line Parameter and Simulation Parameters**
  - Make sure the units are in Mils which is default



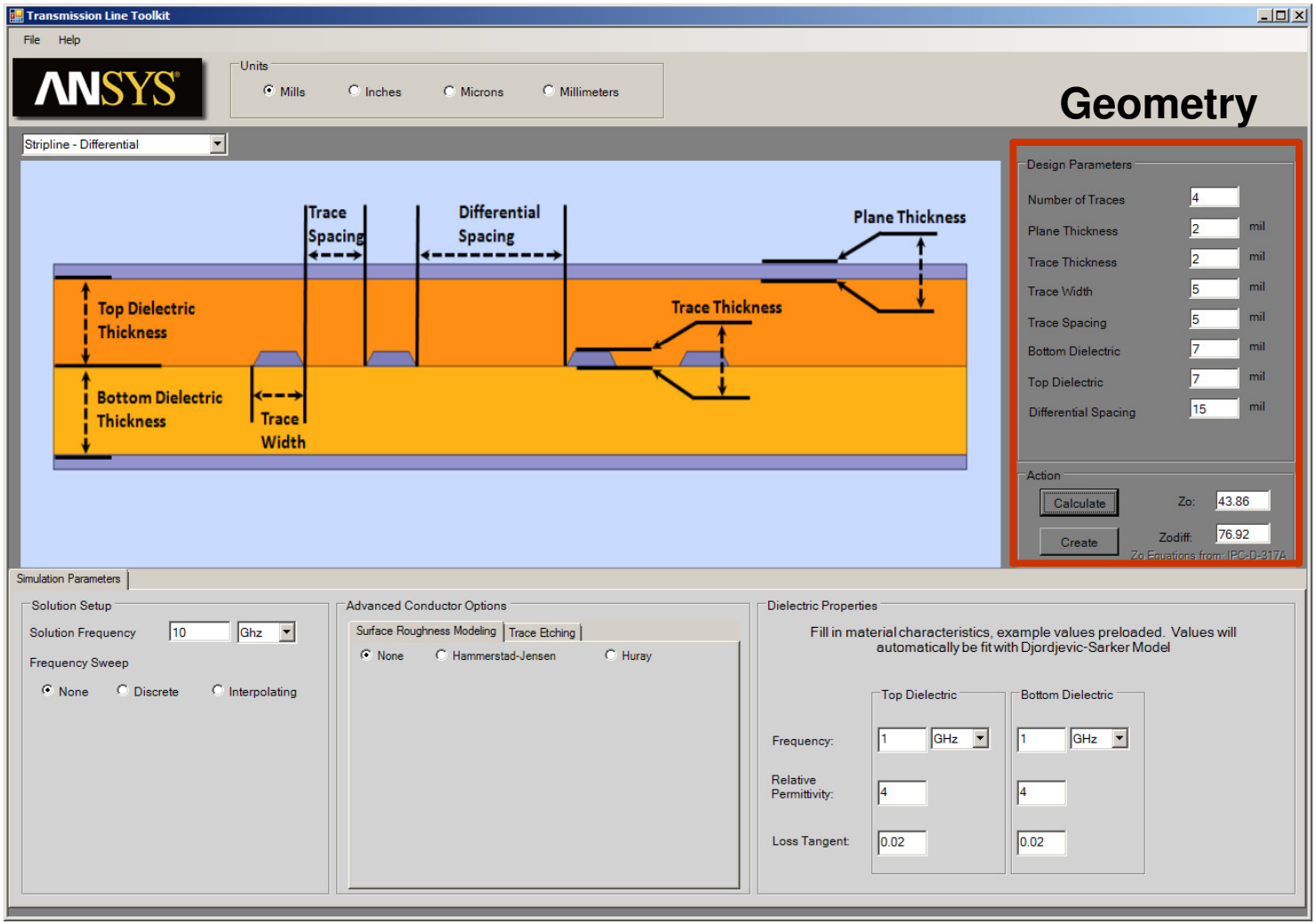
# Transmission Line Tool Kit

- **Setup Transmission Line Parameter and Simulation Parameters**
  - Select Stripline – Differential Line Type from the drop down menu



# Transmission Line Tool Kit

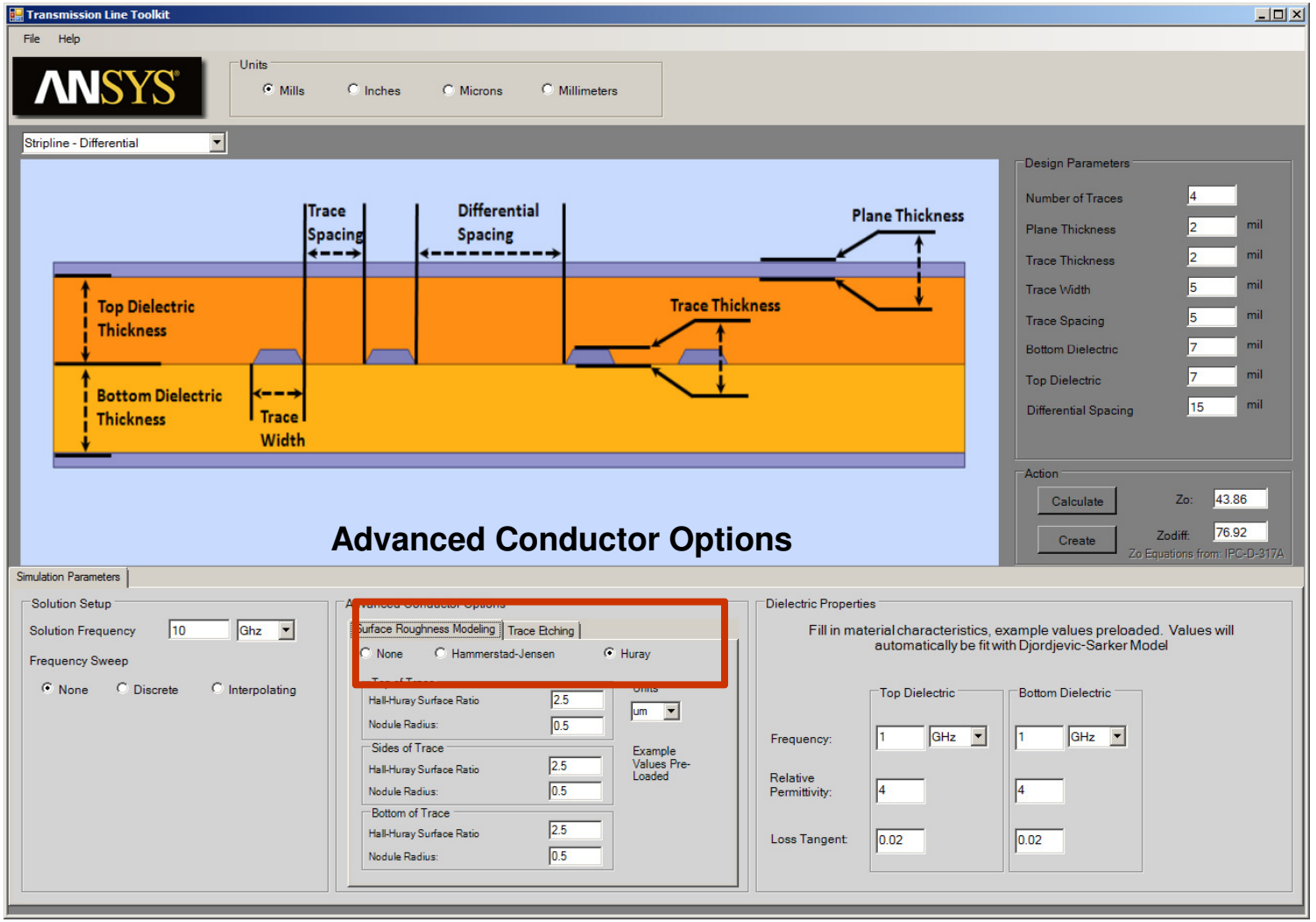
- **Setup Transmission Line Parameter**
  - Use the Transmission Line Design Parameters shown in the window below. These were explained in slide #3



# Transmission Line Tool Kit

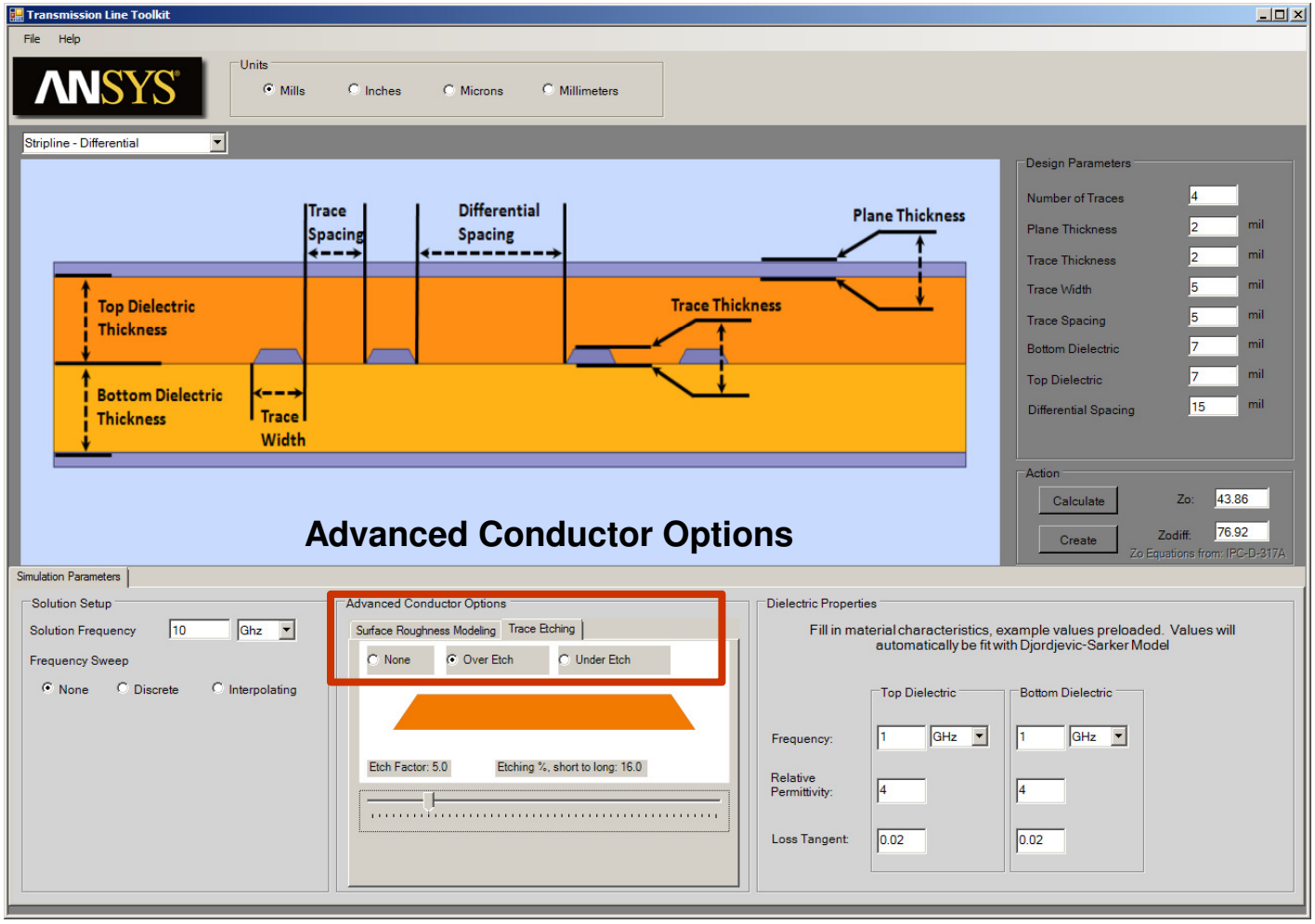
- **Setup Advanced Conductor Options: Surface Roughness**
  - Select Hall-Huray surface roughness model with the default values



# Transmission Line Tool Kit

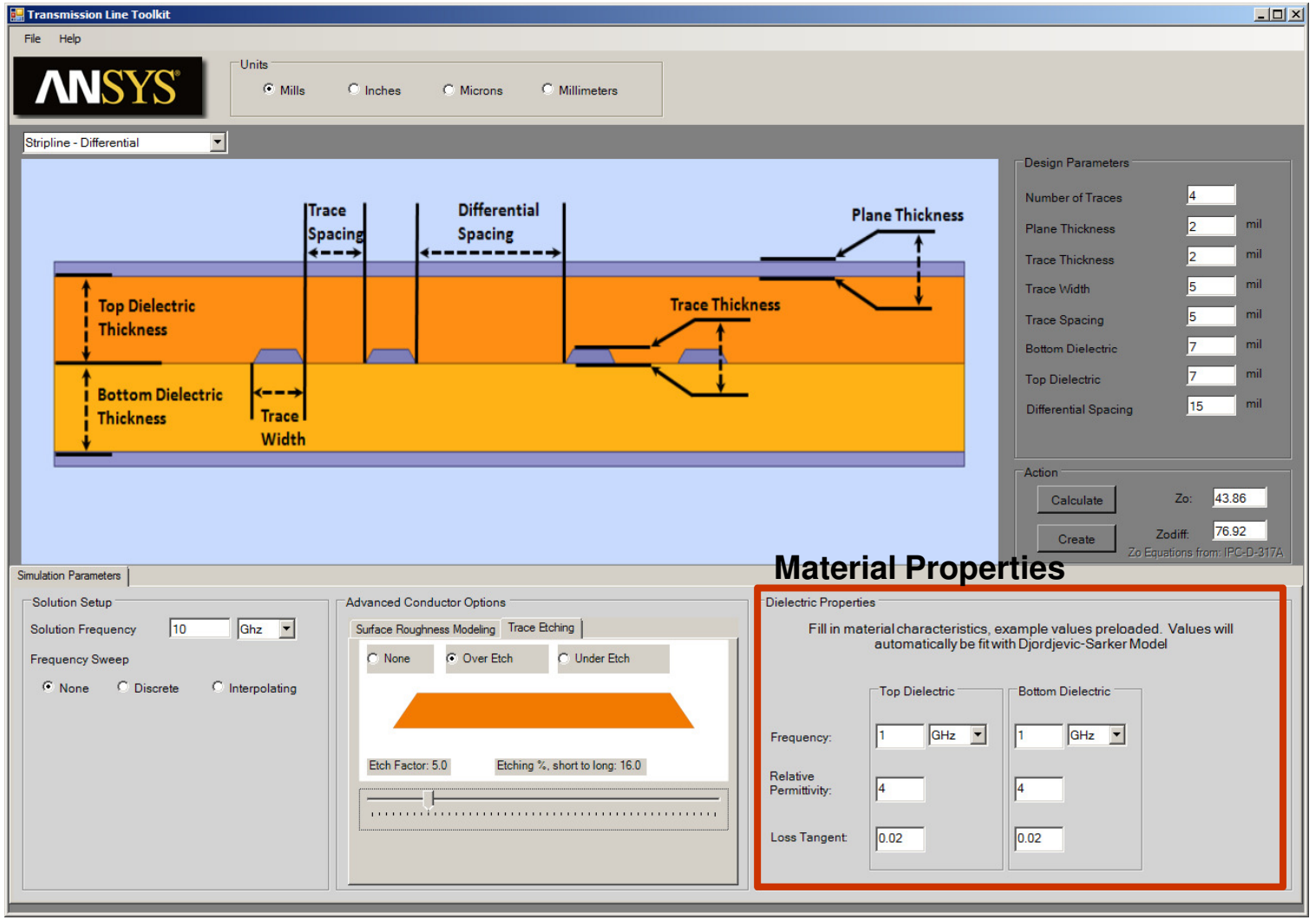
- **Setup Advanced Conductor Options: Trace Etching**
  - Click on the **Trace Etching** tab and add **Over Etch** factor of **5** using the slider



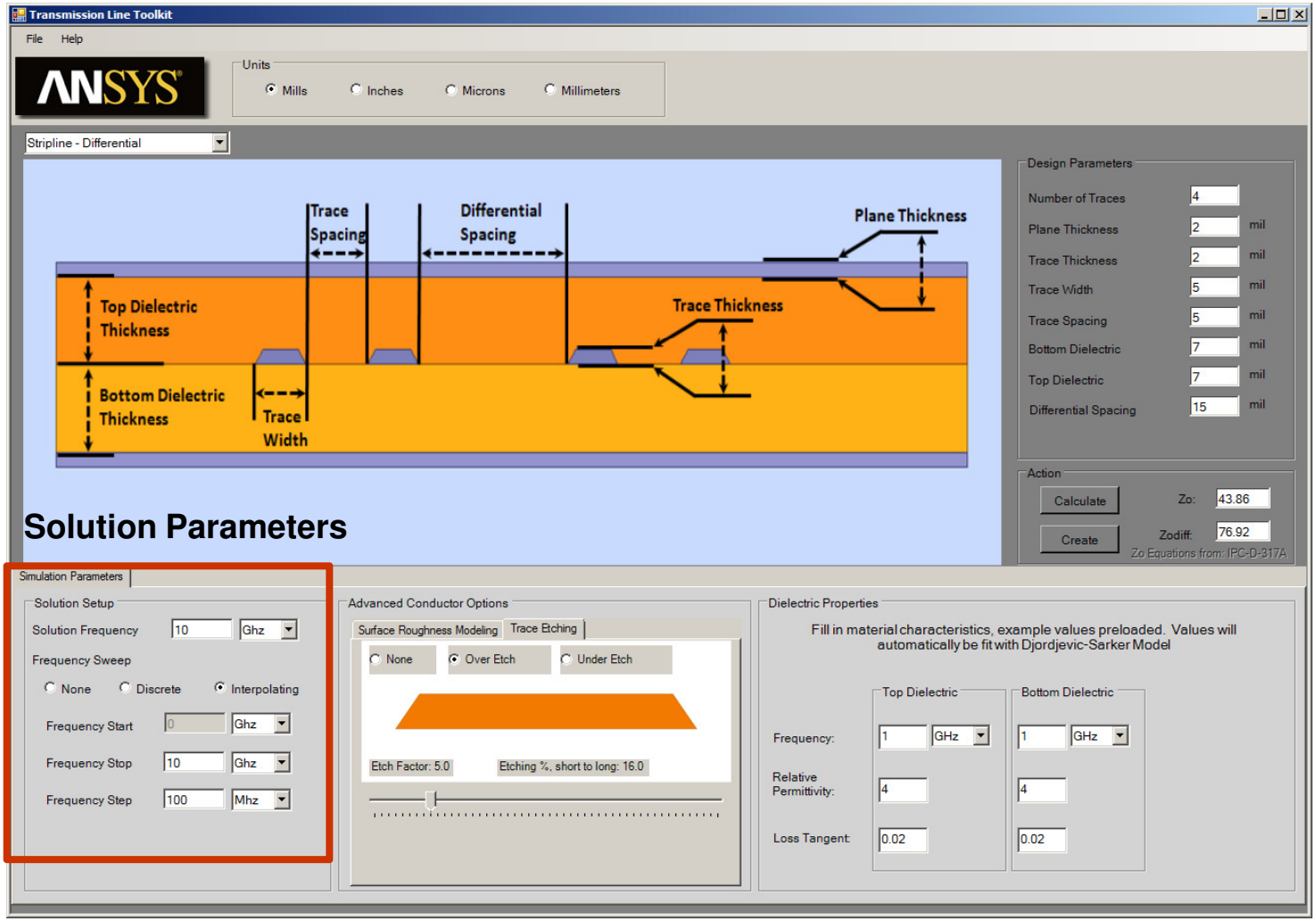
# Transmission Line Tool Kit

- **Setup Dielectric Material**
  - For this exercise, use permittivity of 4.0 and loss tangent of 0.02 at 1 GHz for both the top and bottom dielectric.



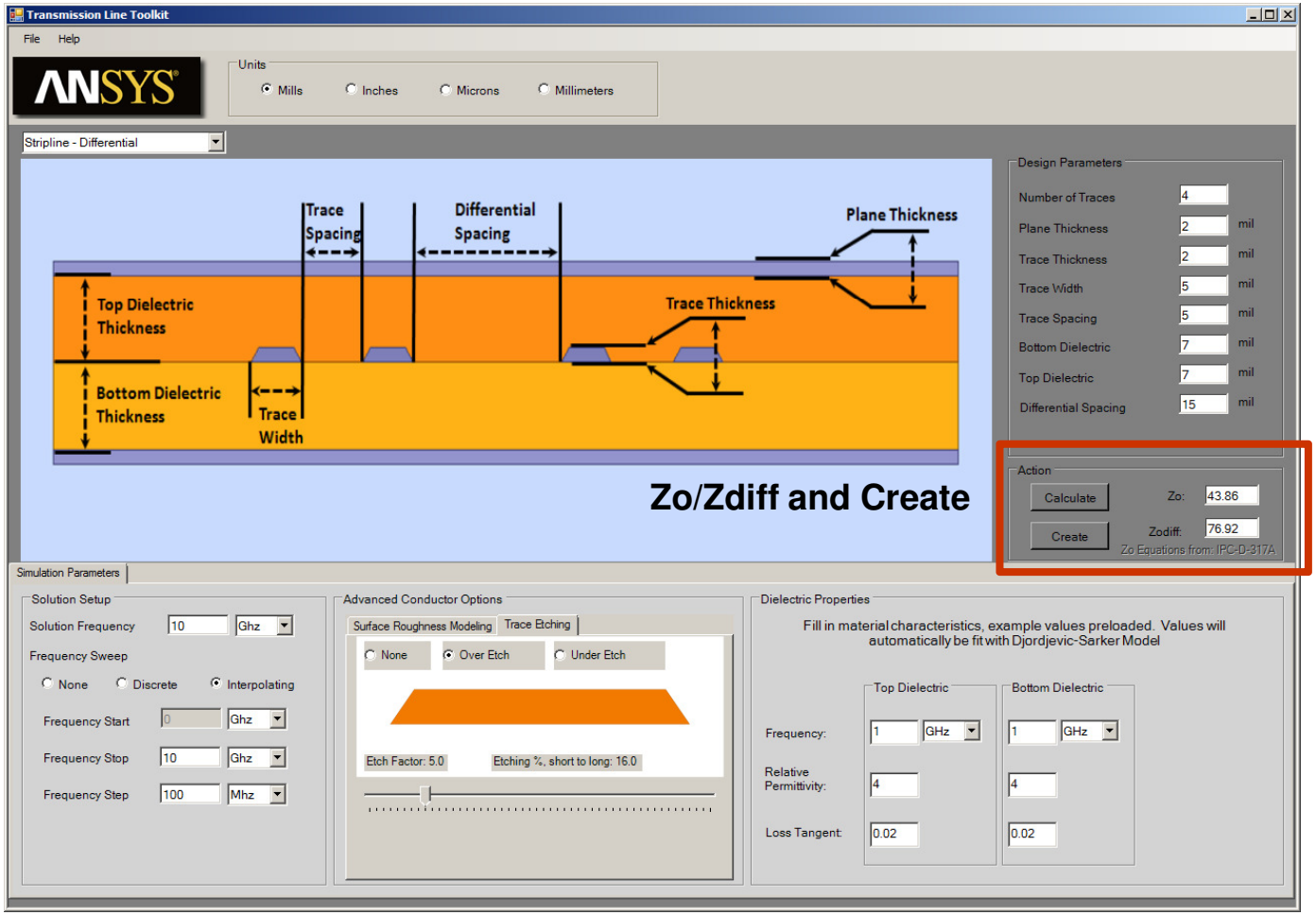
# Transmission Line Tool Kit

- **Setup Simulation Parameters**
  - Select Solution Frequency of 10 GHz
  - Also select Interpolating sweep from 0 – 10 GHz



# Transmission Line Tool Kit

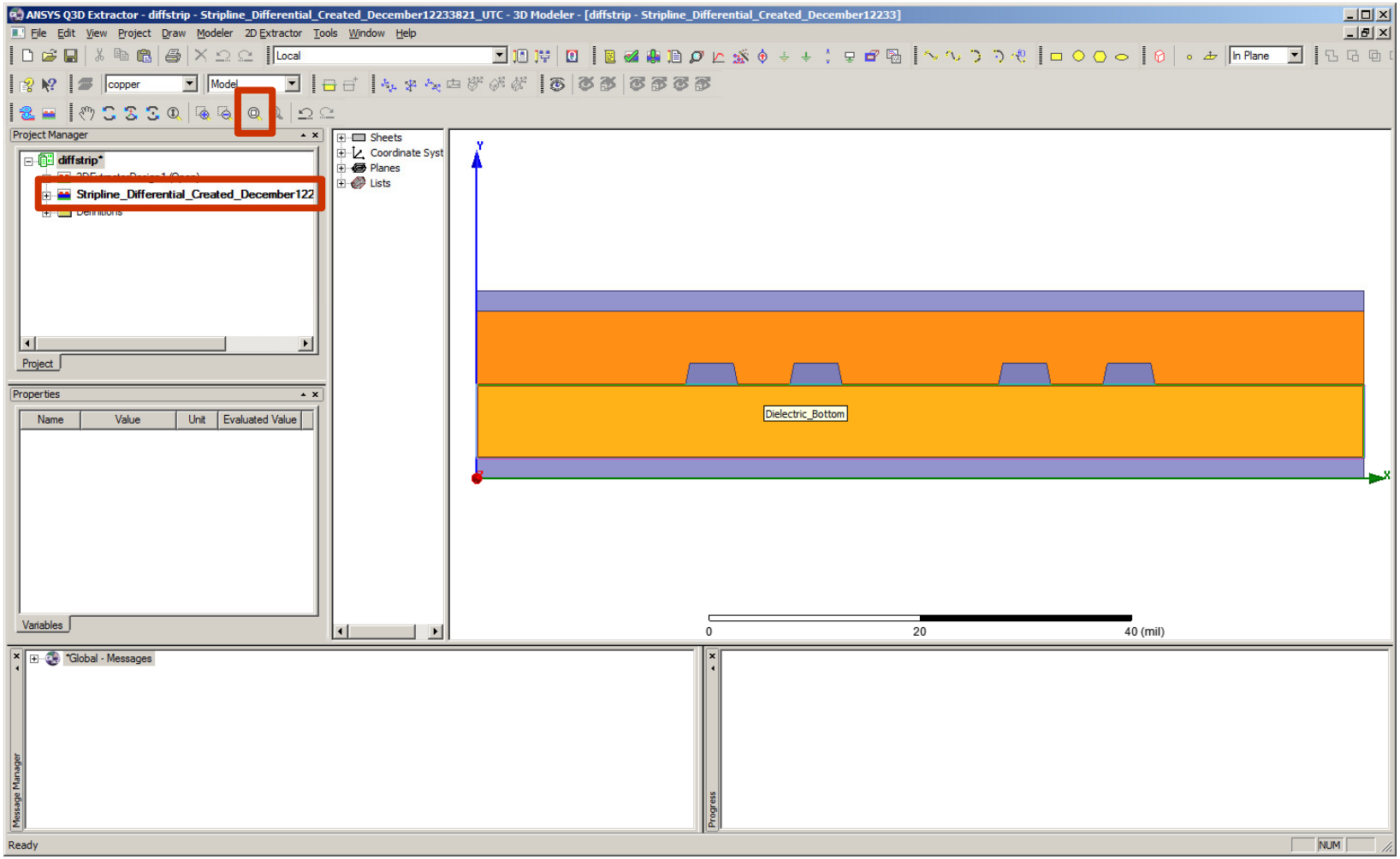
- **Calculate Analytical Zo and Zdiff and Create geometry**
  - Zo and Zdiff is calculated using analytically using equation specified by IPC-D-317A
  - Click on **Create** to create the geometry to be solved using 2D Field Solver. This creates a new project in the project manager



# 2D Parameter Extractor

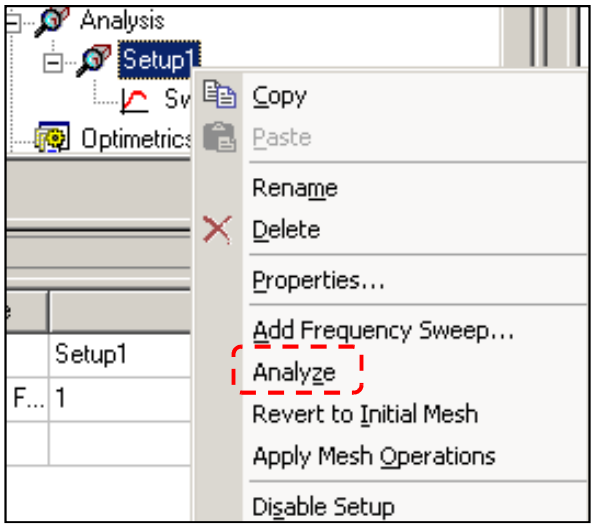
- **Exit out of Toolkit by clicking on File > Exit**
  - You see the window below after you exit. A new project is created in the project manager window. You may need to do CTRL-D/FIT ALL to see the transmission line model



# 2D Extractor

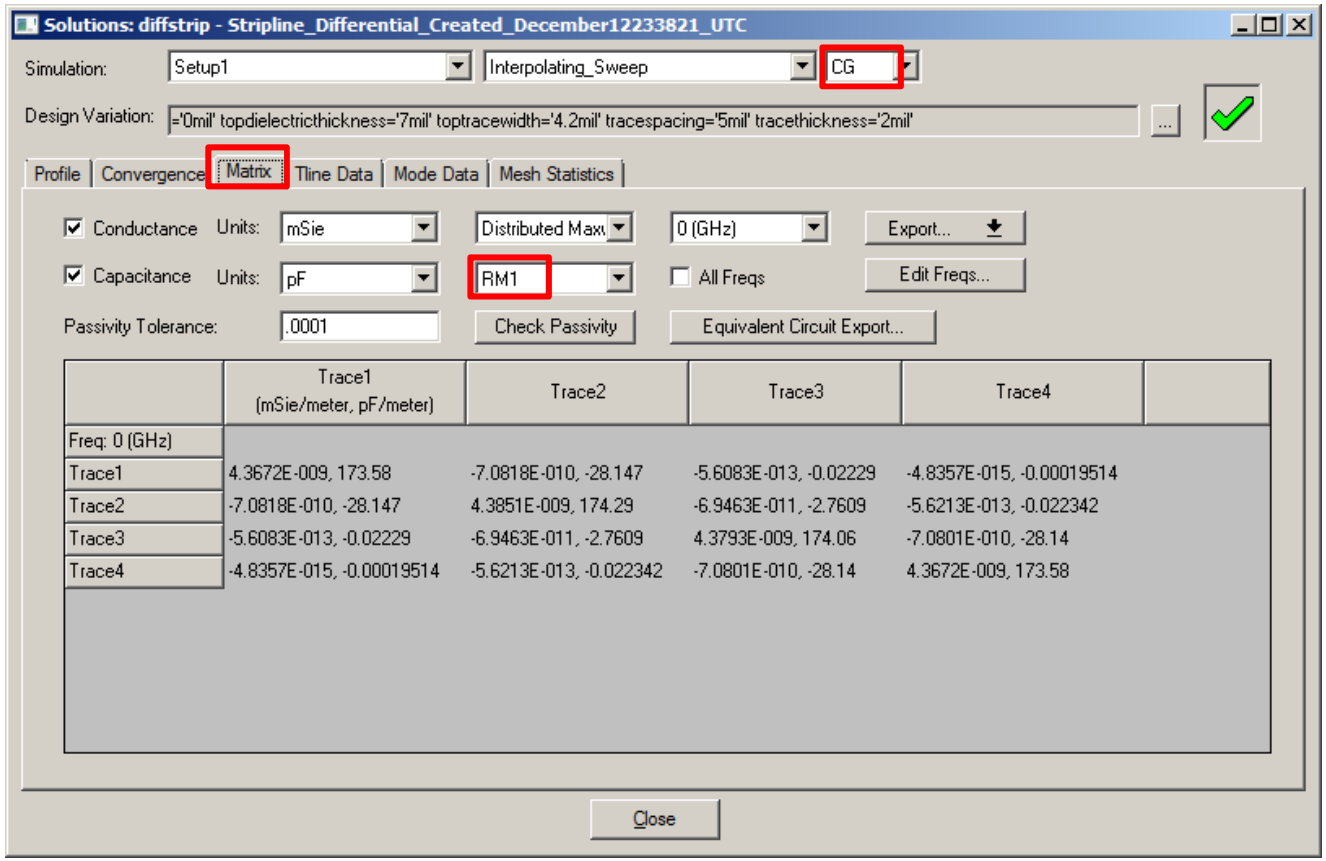
- **Run the Analysis**
  - Run the analysis by clicking with the right mouse button on **Setup1** and choosing **Analyze**.



# Results

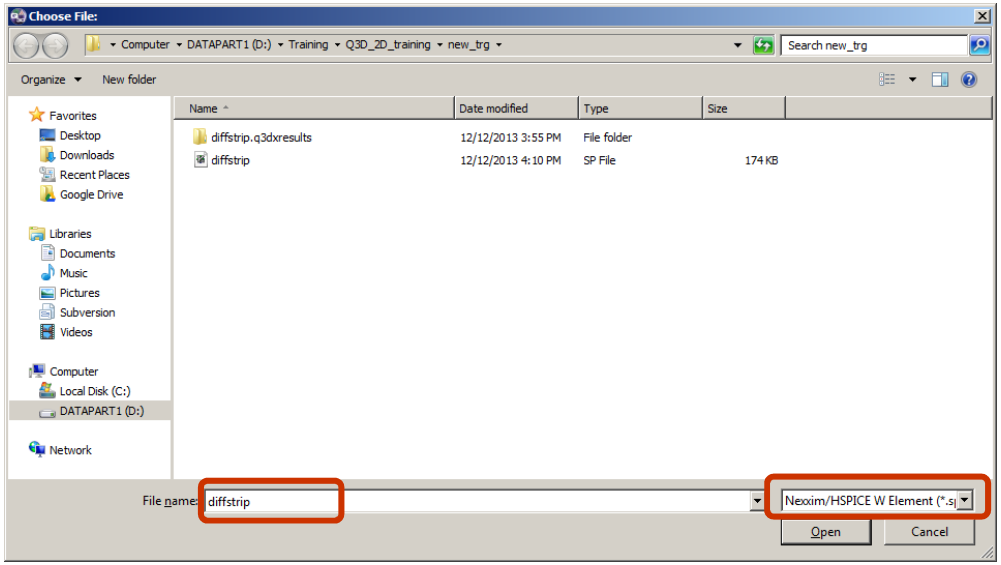
- **Solution Data**
  - Select the menu item ***2D Extractor > Solution Data***
    - To view the RLGC Matrix Data**,** Click the **Matrix** Tab
    - To view **CG** matrix, select **CG** from the drop down list
    - Select **RM1** matrix which is a reduced matrix by grounding the TOP plane in the **Reduce Matrix** operation
    - You can view the **RL** matrix selecting **RL** from the drop down list

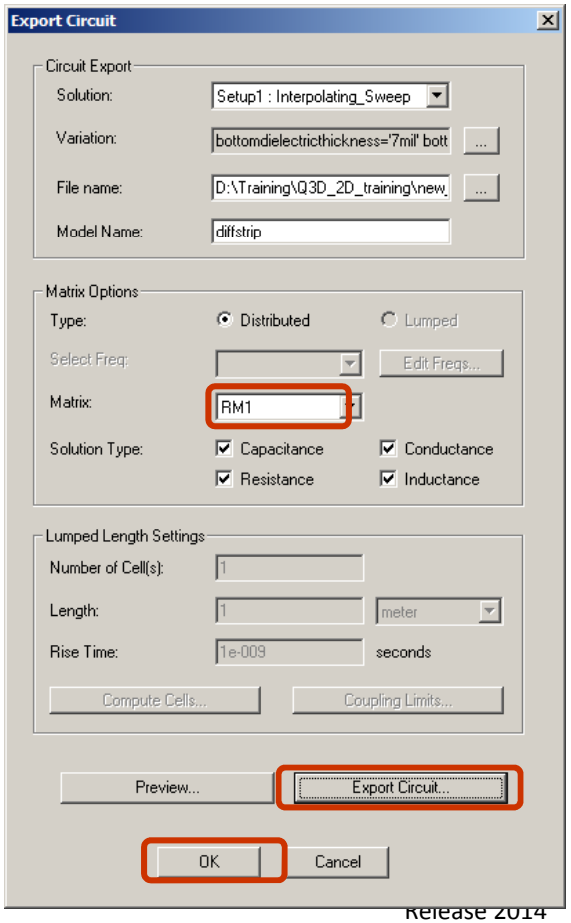


# 2D Extractor

- **Export the W-Element Model**
  - Click with the right mouse button on the **Setup1** in the **Project Manager**. Choose the option **Export Circuit…**
  - Be sure to select **Setup1 : Interpolating_sweep** for the solution so that frequency dependence is included in the model.
  - Press the [...] next to **File name** and browse to the location where the model should be saved.
  - Select **Nexxim/HSPICE W Element (*.sp)** as the file type.
  - Use the default file name **diffstrip** and Press **Open**.
  - Select **RM1** matrix from the drop down list
  - Press **Export Circuit…** to write the model to the file.
  - Press the **OK** button to exit.

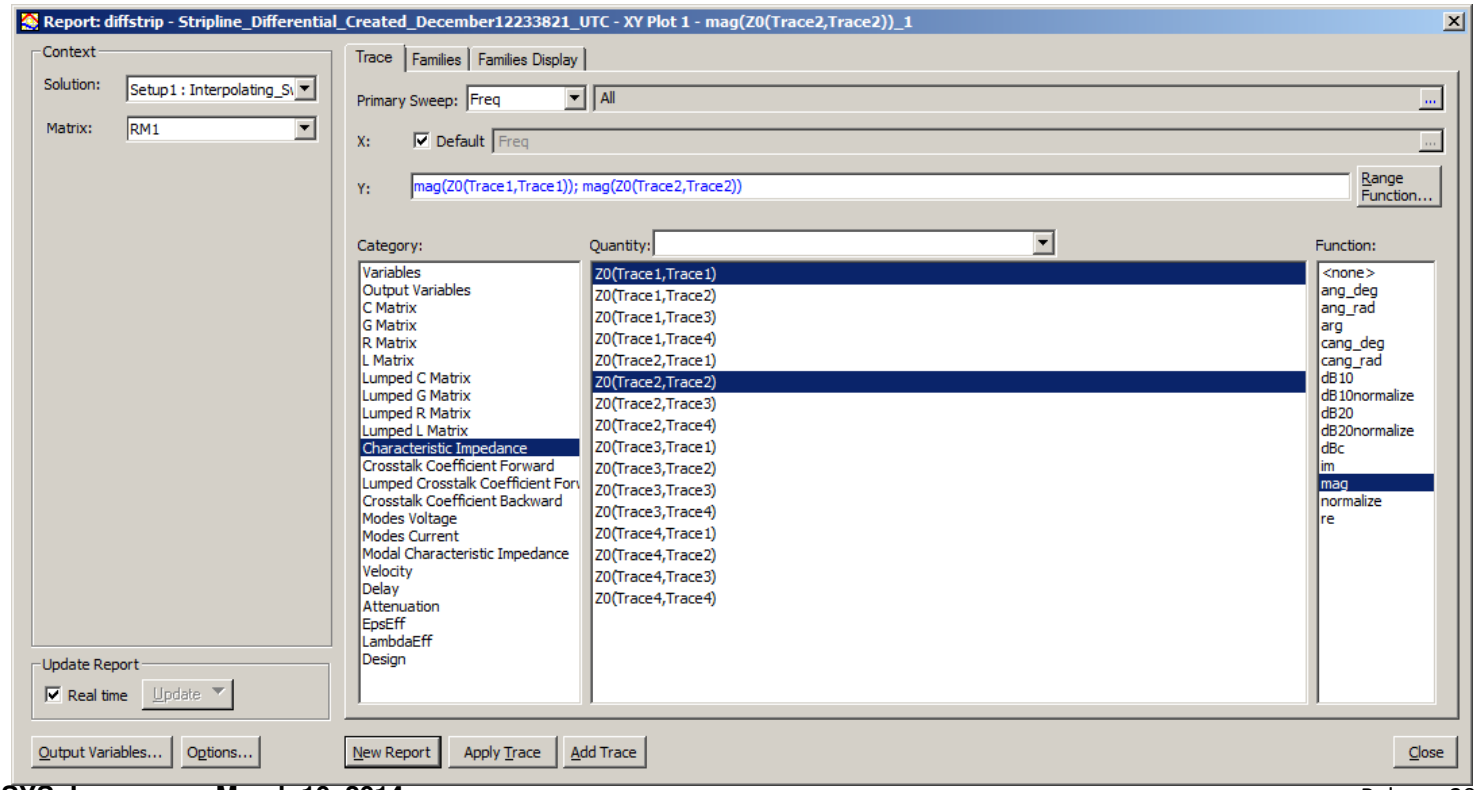


# Zo Plot

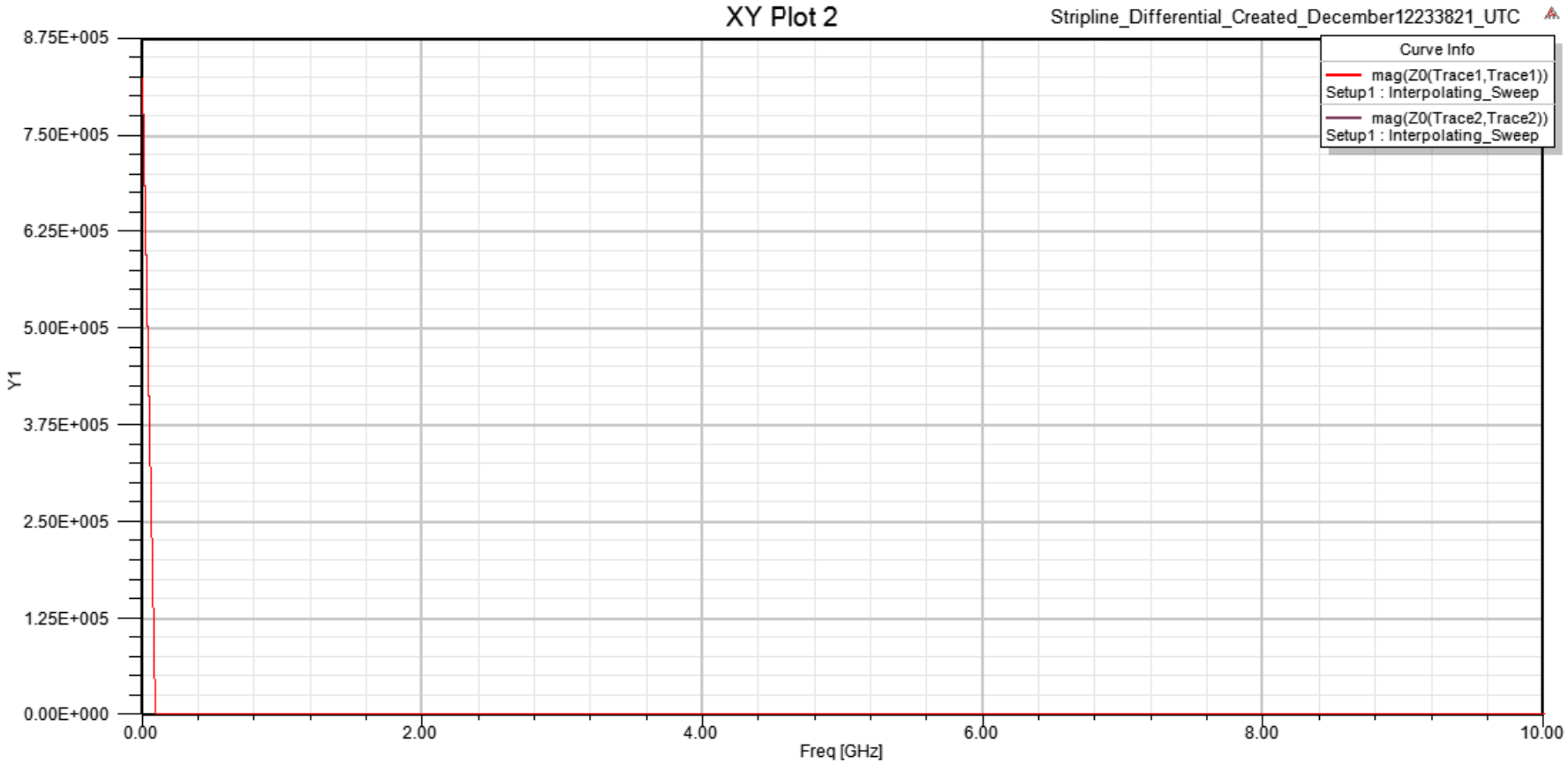
- **Plot Characteristic Impedance**
  - Select the menu item ***2D Extractor> Results> Create Matrix Report> Rectangular Plot***.
  - From the Create Report dialog box
    - Category: **Characteristic Impedance**
    - Quantity: **Z0(trace1, trace1), Z0(trace2, trace2)**
    - Function: **mag**
    - Press **New Report**
    - Press **Close**



# Zo Plot

- This is the plot you see with default setting
- Double click anywhere in the plot area select tab **X Scaling.** Specify **Min** as 0.01 and **Max** as 10, **Spacing** of 5 and **Minor Ticks** as 5
- Select Tab **Y1 Scaling.** Specify **Min** of 0 and **Max** of 80 and spacing of 10 and Minor Ticks of 2. The Zo plot should look like the one on the next slide now.



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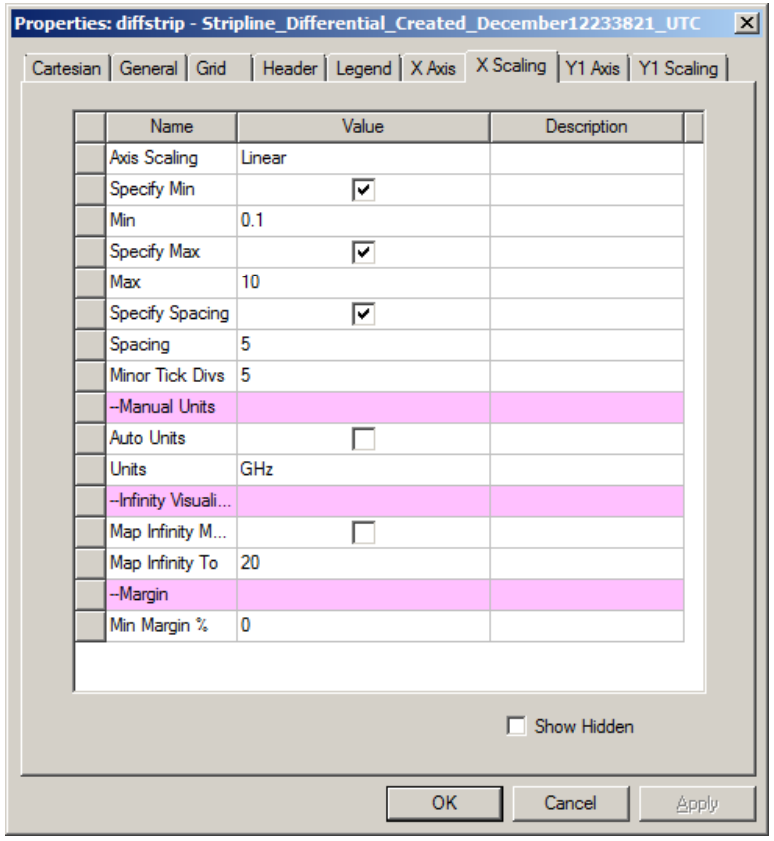


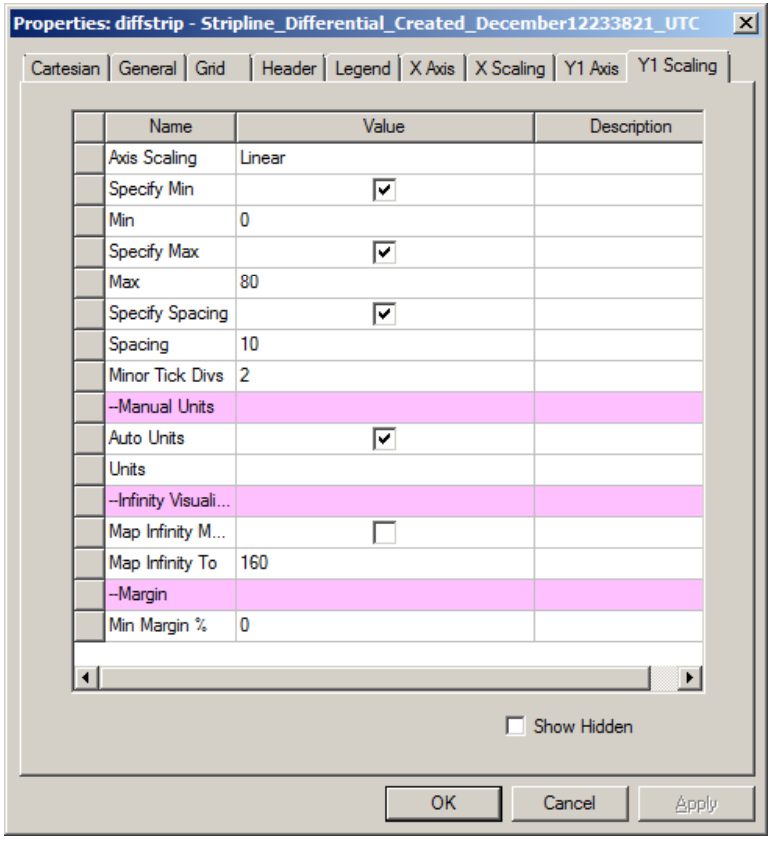

# Zo Plot