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Eagleware PN 13
Electrical to Physical
with Advanced TLINE
Product Note

Translating between physical processes with Advanced TLINE
Electrical to Physical with Advanced TLINE

The popular TLINE program is now integrated into the schematic capture program. With the click of a button, schematics are changed from microstrip to stripline, coplanar waveguide, or other physical process.

In many preliminary designs, matching elements in the initial schematic are “electrical.” This means that the elements contain only electrically descriptive parameters (e.g. theta and impedance) rather than physically descriptive data such as width and length. Figure 1 shows a zoomed portion of a LNA schematic to illustrate these electrical parameters.

The GENESYS program TLINE has been enhanced to include several exciting new features:

1. Advanced mode integration within the GENESYS environment (Advanced TLINE);
2. Automatic conversion of electrical schematics to physical (e.g. microstrip, stripline, coplanar waveguide);
3. Automatic conversion of physical schematics to electrical;
4. Automatic insertion of Disco’s (Eagleware’s new discontinuity models).

Entire schematics (or portions of schematics) are converted between electrical and physical models by using the new Convert function from the schematic menu, shown in Figure 2.

With version 8.0, Eagleware also introduces Discos®, the automatic discontinuity model. Discontinuities exist in any distributed circuit where a discontinuous metal pattern exists, as in a bend or step in width. These discontinuities are important because they nearly always perturb the desired response in some way. However, they are purely a modeling issue since they are not considered when generating a layout. Therefore, engineers often
spend lots of time including these models in simulations simply out of necessity for accurate simulations. Advanced TLINE automatically places these models, and automatically "absorbs" these models into the adjacent lines to preserve the response. To illustrate this concept, Figure 3 shows a microstrip cross (two metal traces which intersect at a right angle), and the equivalent schematic diagram.

The schematic shown in Figure 3 includes four transmission lines, which all intersect at a single point. While this models the physical structure, the schematic simply models four separate lines which intersect, and otherwise do not interact. In reality, this structure exhibits fringing fields between the traces near the intersection point. These fields have a lowpass filtering effect, and can cause extreme disturbance in some cases. So, to model this effect, a "cross" model is inserted in the schematic at the intersection point as shown in Figure 4:

In the Figure 3 schematic, the lines are assumed to join at the exact center of the intersection. However, the cross model uses the reference planes shown at the center of the metal in Figure 3 (shown with dashed lines). In other words, the cross models the metal portion indicated by the dashed square. Since this metal is modeled by the cross, it should not be included in the length of the lines connected to the cross model. For this reason, whenever discontinuities are added to a schematic, it is usually necessary to adjust any lines connected to these discontinuities to compensate for the reference plane shift. Advanced TLINE does this automatically, and calls this step "aborbing Discos©."

Discontinuities are also needed at bends, steps in metal width (or height), and wherever two or more traces meet. Since these models are not actually constructed as part of the layout, they’re purely a manifestation of the modeling process. Advanced TLINE now automatically places these discontinuities, and fills in the required parameters based on the surrounding line connections.
Figure 5 shows the schematic portion from Figure 1 with Discos® added. Also, the lines have been converted to microstrip using Advanced TLINE.

Design Example

Advanced TLINE makes it easy for the engineer to quickly compare designs in various physical realization processes. Figure 6 (left) shows an ideal lowpass elliptic transmission line filter. This filter has 0.1 dB passband ripple, 45 dB of stopband ripple, and a cutoff frequency of 1.350 GHz. The filter as originally designed consists of ideal electrical transmission lines. Using Advanced TLINE, a variety of physical structures is easily explored by simply converting to a new process. Figures 6 through 9 show various equivalent physical structures along with actual line dimensions, all automatically calculated by TLINE based on the ideal structure in Figure 6. Figure 10 shows a comparison of the frequency responses of the filters.
Figure 9: Slabline equivalent for the ideal filter shown in Figure 6.

Figure 10: $S_{21}$ Comparison of standard physical processes with ideal filter characteristics.
Figure 11 shows a cross-sectional comparison of some of the line types which can be automatically converted using Advanced TLINE. Any existing or new schematic containing these elements is automatically converted to any other type by using the Convert function, shown in Figure 2.
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