Design Project #2: *Coupled Line Couplers*

PROJECT SCOPE

Design a **coupled-line coupler** with the following specifications:

Number of sections	5
Center frequency	4 GHz
Coupling	16 dB
Port impedance	50 Ω
Frequency response	Maximally Flat

PROJECT TASKS:

1) Determine the **odd** and **even** mode impedances for each of the **5** sections.

2) For a matched coupler, plot $|S_{11}|^2$, $|S_{21}|^2$, $|S_{31}|^2$ and $|S_{41}|^2$ (in dB) from 0 to 12 GHz.

Q1: *Do these results indicate that your design is correct? Explain **why** you think so.*

3) Compare the scattering parameter values at 2 GHz to those at 10 GHz.

Q2: *What do you observe when comparing the scattering parameter value at 2 GHz and 10 GHz? Use your knowledge of transmission lines and microwave engineering to explain in detail **why** this is true.*

4) Use the markers to determine the **bandwidth** of your design, given that the **coupling** must be numerically greater than 19 dB to satisfy specifications.

5) Place a **short circuit** on port 4 and replot $|S_{11}|^2$, $|S_{21}|^2$, $|S_{31}|^2$ from 0 to 12 GHz.

Q3: *How do these results compare to the case where port four is terminated in a matched load (i.e., task 2)? Use your knowledge of the physical behavior of coupled-line couplers to explain **why** you get this result.*

6) Now place a short circuit on port 2 and replot $|S_{11}|^2$, $|S_{31}|^2$ and $|S_{41}|^2$ from 0 to 12 GHz.

Q4: *How do these results compare to the case where port four is terminated in a matched load (i.e., task 2)? Use your knowledge of the physical behavior coupled-line couplers to explain in detail **why** you get this result.*

*Perhaps you could use a signal flow graph (using an approximate scattering parameters of a 4-port symmetric coupler at its design frequency) to help demonstrate **why** you observed the scattering parameter values at the design frequency of 4 GHz.*

ADS INFORMATION

1. You will need to use **four** ADS "Term" elements (one for each coupler port).

2. You will need **five** "CLIN" elements, which are the ideal coupled transmission lines found in the "TLines-Ideal" element category.

3. The easiest way to attach a **short circuit** to a coupler port is to simply change the characteristic impedance of the "Term" element at that port (but only at that port!) to a value of $Z_0 = 1\Omega$ (one ohm is as small as ADS will let you make Z_0). This of course is not exactly a short circuit, but it's pretty close.

Of course, you could likewise remove the "Term" element from a coupler port and then connect that port directly to a ground terminal. But, if you remove the "Term" element from a port, then ADS will renumber the remaining ports. For example, if your remove the "Term" element from port 2 and replace it with a short to ground (e.g., task 6), then the terminal at port three will be renamed port 2, and the terminal at port 4 will be renamed as port 3.

This in itself is not particularly bad, but you must make sure you are comparing "apples to apples" when comparing the results of task 2 to the results of task 6. For example, the values of task 6 that are labeled $|S_{21}|$ are actually $|S_{31}|$, if the "Term" element at port 2 is removed.

PROJECT REPORT

The same as project 1.

PROJECT GRADING

The same as project 1.