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**RF/Microwave Circuits 1**

**ADS Lab – 2**

**Microstrip Quadrature Coupler Design and Analysis**

1. The schematic circuit for ideal transmission line quadrature coupler is provided below.

Diagram, schematic

Description automatically generated

The higher level schematic that references the ideal transmission line coupler schematic is shown in below figure.

A picture containing diagram

Description automatically generated

The graphs for S21 and S31 with bandwidths greater than -4dB are provided below.

A picture containing graphical user interface

Description automatically generated

Frequency at greater than -4dB for S21 is plotted.

m2= 2.8GHz ; m1= 2.2GHz

Bandwidth = m2-m1= 2.8-2.2 = 0.6GHz

Chart

Description automatically generated

m3= 1.800GHz ; m4= 3.200GHz

Bandwidth = m4-m3= 3.2-1.8 = 1.4GHz

1. **Section 2**
2. (ii)The bandwidth for S21 plot when plotted for greater than or equal to -4dB is 0.6GHz

Bandwidth for S31 plot when plotted for greater than or equal to -4dB is 1.4GHz

(iii) The plot for S11 where the bandwidth over which the isolation is greater than or equal to 20dB is shown below.

A picture containing chart

Description automatically generated

Bandwidth = m6-m5 = 2.650-2.350= 0.3

The plot for S21 where the bandwidth over which the isolation is greater than or equal to 20dB is shown below.

Chart

Description automatically generated

Bandwidth = m2-m1= 3.750-1.250= 2.5GHz

The plot for S31 where the bandwidth over which the isolation is greater than or equal to 20dB is shown below.

A picture containing graphical user interface

Description automatically generated

Bandwidth = m4-m3= 5.450-4.450 = 1GHz

The plot for S41 where the bandwidth over which the isolation is greater than or equal to 20dB is shown below.

Graphical user interface, chart

Description automatically generated

Bandwidth= m8-m7= 2.650-2.350= 0.3GHz

(v) Plot of phase for S21 and S31 is given below.

Graphical user interface, chart, line chart

Description automatically generated

Phase difference for two frequencies of two plots is= -90-(-180) = 90deg

After disconnecting the termination port 4 and connecting a 50ohn resistor to that open port and simulate it.

Plot for the above circuit with 3 ports is as below.

A picture containing chart

Description automatically generated

The plot before removing the termination 4 is as below.

Chart, box and whisker chart

Description automatically generated

Here we can observe the difference as since we removed a port from the 4 port circuit, we only get the graph for those 3 ports. There is no graph for the 4th port like before.

Now change the resistor value to 0ohm and re-simulate the schematic.

We will get the plot for S11, S21, S31 as below.

Chart, scatter chart

Description automatically generated

Since there is no port 4 in this schematic there will be no graph for port 4 and there is no change with the centre frequency.

Isolation for port 1 remains same.

**Section 3: Microstrip Quadrature Coupler**

Generate the schematic of microstrip quadrature coupler.

Diagram, schematic

Description automatically generated

Now generate a higher level schematic like before.

Diagram

Description automatically generated

Simulate the above higher level schematic and plot the graphs for S55, S65, S75, S85.

A picture containing graphical user interface

Description automatically generated

Now plot the graphs of phase for the same S55, S65, S75, S85.

Graphical user interface

Description automatically generated