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Size and Design of BroadBand Coupler

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ABSTRACT

In this article, the microstrip structure is applied to the cnception branch-lign coupler hybrid. The simulation results of the coupler (BLC) to three branches per ADS MOMENTUM are presented as S parameter in module and phase in the two band Ku and K. The use of coupled microstrip lines for the design of the couplers allows a wideband behavior with 25% of relative bandwidth.

Key words : coupler, branch-lign, Wide band

1. INTRODUCTION

The couplers junction is one of the most passive components used in modern communication systems [7]. These hybrid couplers are key elements in the design of microwave devices such as power amplifiers, mixers and antenna systems due to their simplicity, wide bandwidth power distribution, and high isolation between ports [4]-[6].

Systems generally require wireless communication antennas able to operate in different frequency ranges to meet different communication protocols [3]-[5], this can be done using broadband antennas and multi-band but these are large and difficult to integrate into small mobile devices. This concern with frequency agility is also the need to increase the directivity of the antenna; we proceed to that in groups of multiple antennas [1].

The wide-band couplers typically use multi-section coupler, the coupled lines, or the Lange couplers. The coupler ordinary scale (2 branches) is relatively narrow band and provides a bandwidth of the order of 10% [4]. Several techniques for improving the bandwidth of a BLC have been proposed.

This work is unscrewed into two parts. The first part devoted to the theoretical study of some directional couplers with a detailed development of the 3 dB coupler with two branches. In the second part we will make a simulation on the coupler (3dB,90°) with three branches broadband on both Ku and K using ADS software.

2. THEORETICAL STUDY OF COUPLERS

1.1 Directional couplers

A directional coupler is a octopuses bringing together two pairs of lines of the lines of such a pair ((1) and (3) or (2) and (4)) are decoupled.

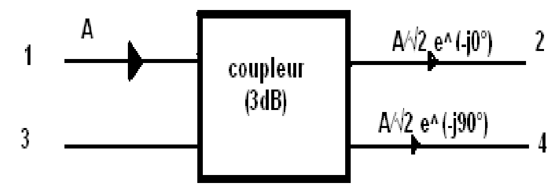


Figure 1: Directional Coupler with incoming wave by (1)

The directional coupler is characterized by three parameters:

- The coupling: $C_{dB} = 10\text{Log}\,(P_1/P_4)$
- The directivity: $D_{dB} = 10\log\left(\frac{P_4}{P_3}\right)$
- The insulation: $I_{dB} = 10\text{ Log}\,(P_1/P_3)$

1.2 Junction couplers

In these couplers, the coupling is obtained by establishing a connection between two lines. There are two types of couplers junctions, ladder and ring.

A. Coupler Branch-Line

Couplers called "Branch-Line" (Figure 2) are the directional couplers generally used for distribution 3dB energy, with a phase difference of 90° between the way "direct" and the way "coupled" [1-2]. This kind of coupler is frequently performed in microstrip technology or Tri-plaque and is part of couplers so-called " phase quadrature".

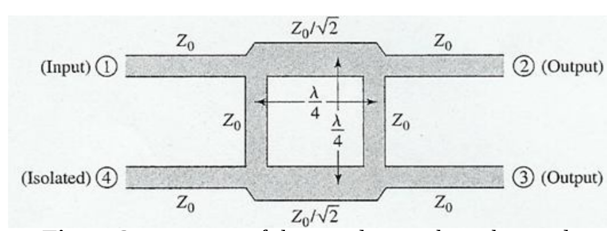


Figure 2: geometry of the coupler two branches scale

According to the diagram above, the power between the port 1 and will be divided between the port 2 (direct path), and port 3 (channel coupled) with a phase difference of 90° between the outputs. No energy is transmitted to port 4 (this is the path isolated).

We can observe that the coupler has a high degree of symmetry. Any port may be used as an input. This symmetry is reflected by examining the S-matrix, since each line can be obtained by transposing the first. So we decompose this study on the even mode and odd mode analysis.

1.3 Even and odd analysis mode

We will first draw the circuit impedance coupler reduced (Figure 3), where it is understood that each row represents a transmission line with a characteristic impedance normalized to Z_0. We will take an incident wave of amplitude 1 incident at port 1.

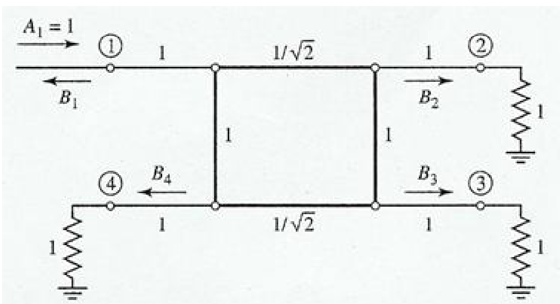


Figure 3: standardized form of branch coupler

The circuit can now be decomposed into two geometrically identical quadrupoles. When this octopole is excited by a wave unit entering by one of its channels. We located in a case which is asymmetrical in terms of electromagnetic.

A. Even mode

The octopuses is excited in the tracks (1) and (4) by half amplitude wave in phase (even mode). The geometric plane of symmetry circuit behaves as an open circuit, or $Z = \infty$ we say that it is a magnetic wall sharing octopole two identical quadrupoles Qp.

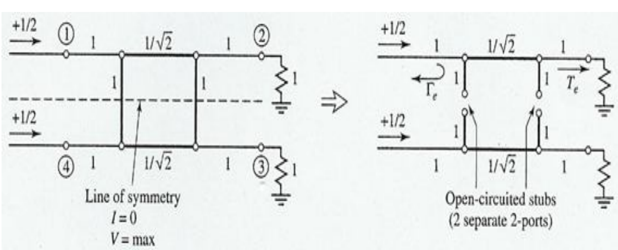


Figure 4: Excitation even mode

This study should allow the determination of the reflection coefficients Rp and Tp transmission characteristics of the quadrupole. Thus giving us the outgoing waves of octopole excited even mode.

$$B_{1p} = R_p/2;\ B_{2p} = T_p/2;\ B_{3p} = T_p/2;\ B_{4p} = R_p/2$$

B. Odd mode

The octopuses is excited in the tracks (1) and (4) with wave amplitude 1/2 in phase opposition (odd mode). The geometric symmetry plane behaves like a short circuit, or Z = 0 we say that is an electric wall sharing two quadrupole octopole identiquesQi.

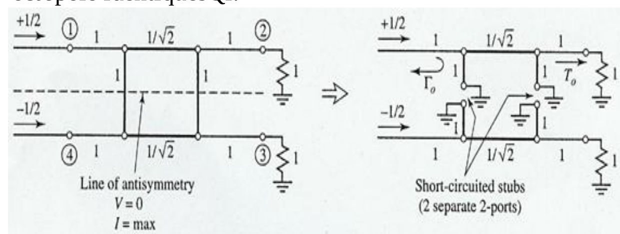


Figure 5: Excitation odd mode

This study should allow the determination of the reflection coefficients Ri and Ti transmission characteristics of the quadrupole. Thus giving us the outgoing waves of octopole excited odd mode.

$$B_{1i} = R_i/2;\ B_{2i} = T_i/2;\ B_{3i} = -T_i/2;\ B_{4i} = -R_i/2;$$

Superposition of outgoing waves of octopole obtained if we give even and odd waves of octopole outgoing wave excited by unity in the way (1). We therefore obtain the S-parameters in the following form:

$$S_{11} = \frac{Rp+Ri}{2};\ S_{21} = \frac{Tp+Ti}{2};\ S_{31} = \frac{Tp-Ti}{2};\ S_{41} = \frac{Rp-Ri}{2}$$

Rp: Coefficients of reflection in even mode

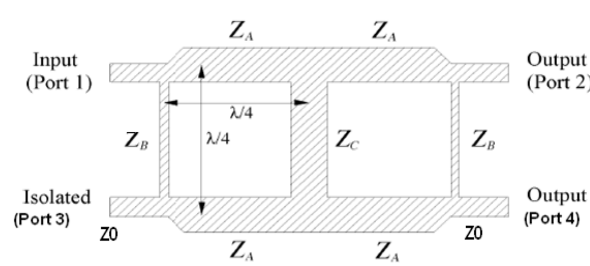
Tp: Coefficients transmission in even mode

Ri: Coefficients of reflection in odd mode

Ti: Coefficients of transmission odd mode

2. SIMULATION OF COUPLER 3BRANCHES

Coupler with two branches is the simplest design couplers scale. For this it is possible to develop three or more branches. This technique allows to increase the width of the passband and to keep the insulation strip on a higher



frequency.

Figure 6: three-branch coupler

2.1 Band Ku

For our size coupler (3dB, 90 °) with 3 branches, we chose a characteristic impedance for its ports 50 Ω.

The simulation results of the coupler with three branches after optimization are given as to the S parameters (Figure 7).

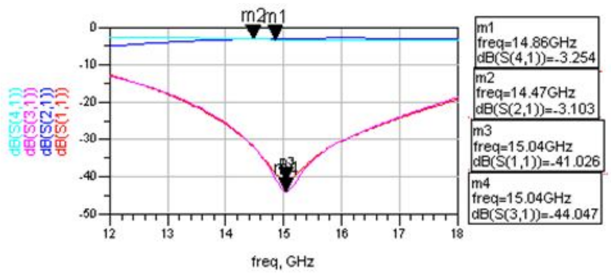


Figure 7: Parameters S amplitude versus frequency

Pathways isolation and reflection show better performance with S parameters amplitude remains below-10dB over the entire frequency band and below-41dB at the center frequency (resonance frequency).

The direct path and coupled channel offer equal in magnitude to the frequency 13.5GHz and 18GHz comprie between. For the direct path, the amplitude of the output power is of the order of-3.1dB, but for the coupled channel, the amplitude is of the order of-3.25dB. A difference of 0.15dB-decoupling between channels which can be interpreted by EMC problems and electromagnetic interaction between the output signals.

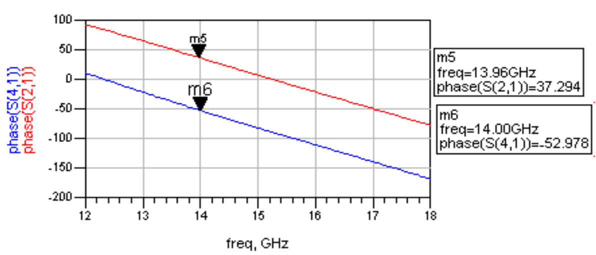


Figure 8: S parameters in phase versus frequency

The output signals of the direct and coupled channel represent a phase shift of about 89.9° with a tolerance of ± 0.1 ° between 14GHz and 18GHZ (Figure 8).

So our coupler is a coupler (3dB, 90 °) in the frequency band of 14GHz and 18GHz range, so a bandwidth of the order of 25%.

2.2 Band K

For our size coupler (3dB, 90 °) with 3 branches, we chose a characteristic impedance for its ports of 70.5 Ω.

After optimization of the coupler, the simulation results are given in the form of S-parameters in Figure 9.

The isolation channels and reflection show good results with the S-parameters in amplitude remain below-10dB on the frequency band between 18GHz and 22GHz.

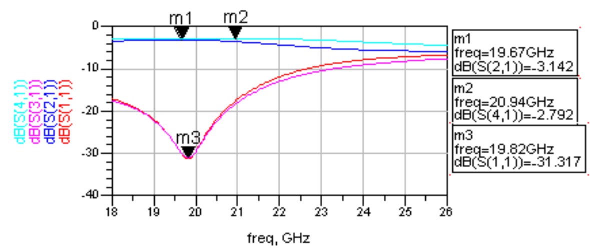


Figure 9: Parameters S amplitude

Pathways provide decoupling equal in magnitude to the frequency band between 18GHzet 21GHz with an average level of about-3dB and a balance of 0.4 dB.

Figure 10: S-parameters phase

In terms of phase, the decoupling means of a phase shift is of the order of 90.14 ° with a deviation of ± 0.2° in between the frequency band between 22 GHz and 18 GHz (Figure 10).

So our coupler is a coupler (3dB, 90 °) in the frequency band between 21 GHz and 18 GHz, so bandwidth in the order of 15%.

3. CONCLUSION

In this work, it was concluded that the realization of such a coupler in microstrip technology in microwave is based on the choice of the impedances of doors and the type of substrate used (permittivity and thickness).

Simulation of broadband coupler was made in the software ADS (MOMENTUM). Simulation results are given as a parameter S, the performance of the coupler three branches are quite satisfactory. They offer higher performance, a parameter S and bandwidth to a width of 25% relative to that of the coupler having two branches.

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