IRACST - International Journal of Computer Science and Information Technology & Security (IJCSITS), ISSN: 2249-9555
Vol. 2, No.2, April 2012

CONCEPTION OF THE COUPLER WITH 3 BRANCHES

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Abstract—**In this paper we present the results simulations of the three branches coupler (3dB, 90 °) by the ADS Momentum. These simulations results are presented Results are presented as parameters [Sij] in module and phase at wide band (K and Ku band) then compared to the published results in recent bibliography. The design of the coupler meets the norm of the coupler microstrip technology.**

Keywords-coupler, ADS, Baranches, Wide band

I. INTRODUCTION

In telecommunications, in modern systems, the antennas must be able to work for different frequency ranges to meet different communication protocols (GSM, DCS, UMTS, WiFi, WiMax,LMDS) this can be done using satellite broadband multi-band but they are bulky and difficult to integrate into small mobile devices [1-6]. With this concern for frequency agility is also the need to increase the antenna directivity, the procedure for it to groups of several antennas. Supplied simultaneously by the same issuer with the interposition of power dividers and phase shifters (couplers), the radiation characteristics depend on both the pattern of each antenna and the distribution in amplitude and phase. This property is exploited to obtain a diagram that could not be obtained with a single radiating element. If it also changes the characteristics of power dividers and phase shifters by electronic means, you can get an almost instantaneous change in the diagram. The couplers are devices allowing obtaining an output power proportional to the input. These are 4-port devices, one of which is closed in its characteristic impedance. The major classes of directional couplers are couplers holes, couplings and couplers by proximity to junctions. Of these, there is the couplers 90° scale that we study in this mini project and have frequently used in the microwave range. They are integrated in components such as phase shifters, mixers and amplifiers balanced [7-8].
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 arms. In the second part we will do a simulation of the coupler (3dB, 90 °) with three branches using ADS software [9][10].

II. THEORETICAL STUDY OF COUPLERS

1. Directional couplers

A directional coupler is an octopole bringing together two pairs of lines so the lines of a pair ((1) and (3) or (2) and (4)) are decoupled

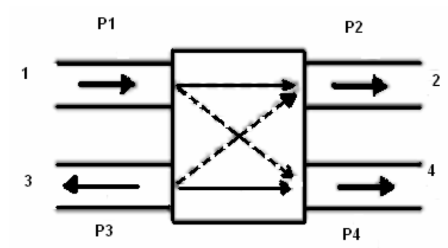

Figure 1: Directional Coupler with incoming wave through (1)

The path (1) or the source is coupled to the tracks (2) and (4), and the way (2) or (4) is coupled to the tracks (1) and (3).
P1 is the power fed into the channel (1), P2, P3 and P4 in the powers outbound channels (2), (3) and (4) when appropriate (Figure 1). The directional coupler is characterized by three parameters:

- Coupling: $C_{dB} = 10Log\,(P_1/P_4)$
- Directivity: $$D_{dB} = 10log\left(\frac{P_4}{P_3}\right)$$
- Insolation: $I_{dB} = 10\,Log\,(P_1/P_3)$

2. Couplers junctions

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

2.1 Coupler-scale or Branch Line

Couplers called "Branch-Line" (Figure 2) directional couplers are generally used for distribution to 3dB of energy, with a phase difference of 90 ° between the way "direct" and the way "coupled". This kind of coupler is commonly done in microstrip technology or Tri-plate, and is one of the couplers so-called "phase quadrature".

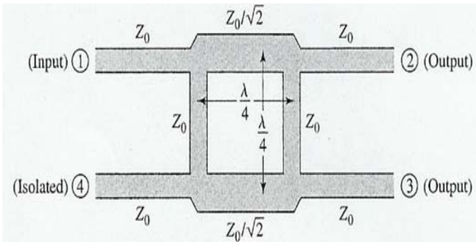

Figure 2: Geometry of the coupler ladder with two branches

According to the diagram above, the energy between the port 1 and will be divided between the port 2 (direct path) and port 3 (coupled channel) with phase difference of 90 ° between the outputs. No energy is transmitted to port 4 (the way it is isolated). These associations Number of Ports / Associated function is purely conventional and can be consistent.

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

S_{11}=(Rp+Ri)/2, S_{21}=(Tp+Ti)/2, S_{31}=(Tp-Ti)/2
S_{41}=(Rp-Ri)2
Rp: Reflection coefficients in pair mode
Tp: Transmission coefficients in pair mode
Ri: Reflection coefficients in odd mode
Ti: Transmission coefficients in odd mode

III. SIMULATION RESULTS OF THE COUPLER WITH 3 BRANCHES

The 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 bandwidth and to keep the insulation on a frequency band higher.

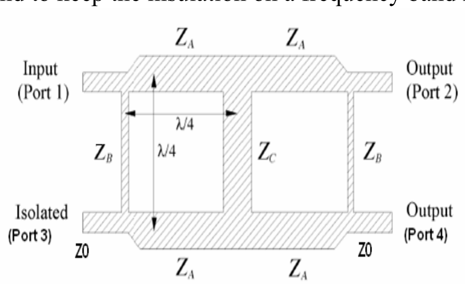

Figure 3: Coupler three branches

To calculate the impedances of the coupler will be interested in the following two conditions:

- Condition for perfect insulation:

$$Z_C = Z_B(Z_A^2 + 1)/2$$

- Condition for a 3 dB coupler:

$$Z_A = Z_C / 1.41 \text{ et } Z_b = 1/0.41$$

A. Ku-band

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

1. Simulation in SCHEMATIC

Simulation results are given as parameters on the S (Figure 4).

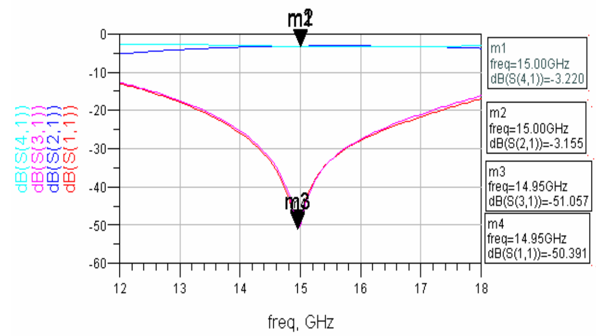

Figure 4: Parameters S amplitude versus frequency

Pathways isolation and reflection perform better with S-parameters in magnitude to remain below-10dB over the entire frequency band and less than-50dB in the center frequency (resonance frequency). The direct path and the path coupled offer equal in amplitude to the center frequency with an average of about -3.2 dB instead of 3 dB and a balance of 0.13 dB. So is the loss of about 0.2dB. In terms of phase, the output signals of the direct path and the path are coupled phase shift of about 89 ° with a deviation of ± 1 ° between 14 and 17 GHz (Figure 5).

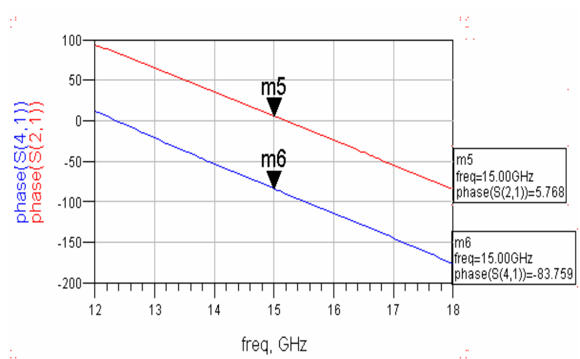

Figure 5: S-parameters in phases depending on frequency

2. Simulation in the LAYOUT

The dimensions of the coupler with three branches after optimization are shown in figure 6.

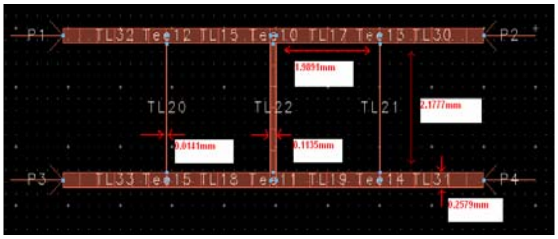

Figure 6: Schematic of the coupler 3 branch in Layout

Simulation results are given as S parameters (figure 7).

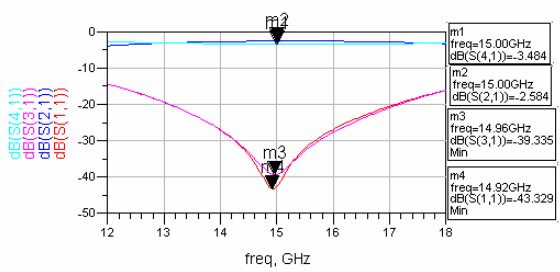

Figure 7: S Parameters amplitude versus frequency

Pathways isolation and reflection always show better performance as the S-parameters with schematic amplitude that remain below-10dB over the entire frequency band and less than-39dB in the center frequency (resonance frequency), so a difference of-11dB, which can be interpreted by the problem of impedance mismatch to enter.
The direct path and the path coupled do not equal in amplitude to the center frequency. For the direct path, the amplitude of the output power is about-2.6dB, but for channel coupled amplitude of about-3.5dB. A difference of-0.9dB between channels decoupling can be interpreted by the problems of compatibility and electromagnetic interaction between the output signals.

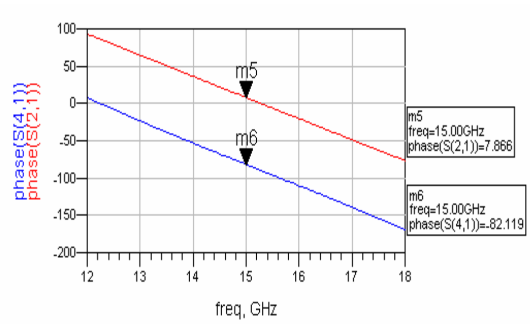

Figure 8: S-parameters in frequency-dependent phase

The output signals of the direct path and the path coupled represent a phase shift of about 89.9 ° with a deviation of ± 0.1° between 13 and 17GHZ (Figure 8). So our coupler is a coupler (3dB, 90°) in the frequency range entre13 and 14.5 GHz.

B. *K-band*

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

1. Simulation in SCHEMATIC

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

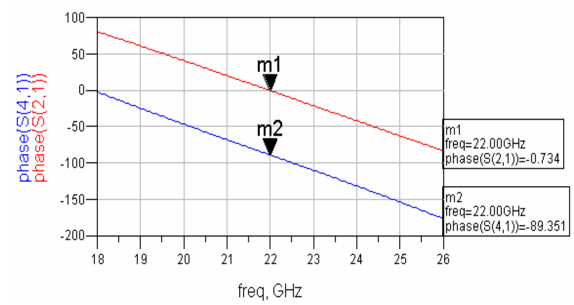

Figure 9: S Parameters amplitude

Pathways isolation and reflection perform better with S-parameters in magnitude to remain below-10dB over the entire frequency band and less than-40dB in the center frequency. The direct path and the path coupled offer equal in amplitude to the center frequency with an average of about -3.3 dB instead of 3 dB and a balance of 0.01 dB. So is the loss of about 0.3dB. In terms of phase, the output signals of the direct path and the path are coupled phase shift of about 88 ° with a deviation of ± 2 ° between 21 and 25 GHz (Figure 10).

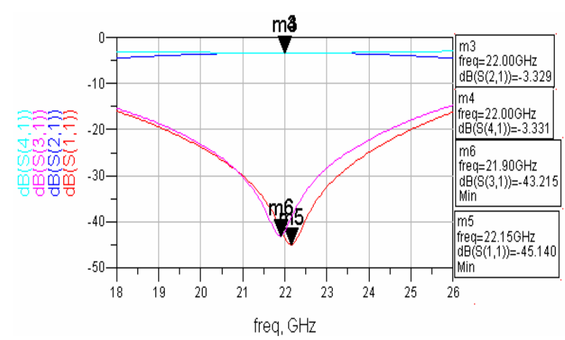

Figure 10: Settings in S phase

2. Simulation in the LAYOUT

Simulation results are shown in Figure II-10.The way isolation and reflection show good results with S-parameters in magnitude to remain below-10dB over the entire frequency band and less than-25dB in the frequency of 20.28GHz. So a shift of 2 GHz compared to the results of the schematic (Figure 11).

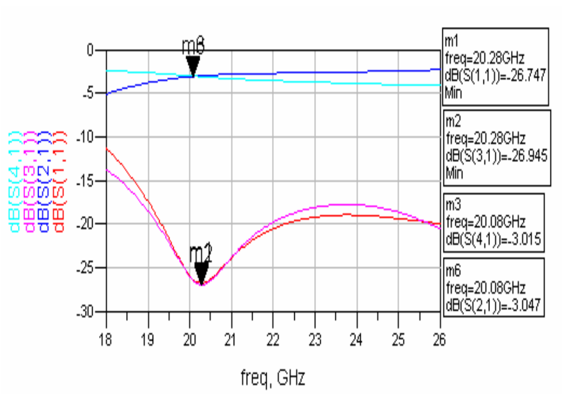

Figure 11: Parameters S amplitude

The ways of decoupling offer equal in amplitude at a frequency of 20.28 GHz with an average of about 3 dB and a balance of 0.1 dB.

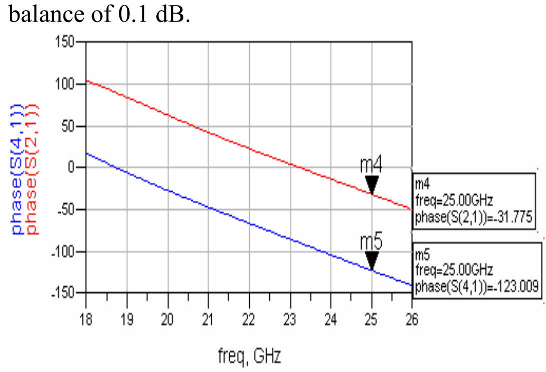

Figure 12: Settings S in phase

In terms of phase, the ways of decoupling is a phase shift of about 89.9 ° with a deviation of ± 0.2 ° between the frequency band between 19 and 25 GHz (Figure 12). So our coupler is a coupler (3dB, 90 °) in the frequency band between 19.8 and 20.8GHz.

IV. Conclusion

In this work, it was concluded that the realization of such a coupler in microstrip technology in the millimeter is based on the choice of the impedances of doors and the type of substrate used (the permittivity and thickness). The simulation was done in both types of software ADS (SCHEMATIC and MOMENTUM) for the deference between these two types the one hand and to get an idea of the actual implementation (MOMENTUM) of the coupler on the other (the operating band of the coupler).

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