Chapter 3

Single Stage Simulator and Design

3.1 Introduction

The complex transmitter consists of analog amplifier circuit、digital DAC converter and many RF module. There are MMIC 、Balance PA 、Coupler.

3.2 MMIC

The HMMC-5618 6-20GHz MMIC[9] is an efficient two-stage medium-power amplifier that is designed to be used as a cascadable intermediate gain block for EW applications as shown in Figure 3.1 3.2. In communication systems, it can be used as an amplifier for a local oscillator or as a transmit amplifier. It is fabricated using a PHEMT integrated circuit structure that provides exceptional efficiency and flat gain performance. During typical operation, with a single 5 volt DC power supply, each gain stage is biased for Class-A operation for optimal power output with minimal distortion. The RF input and RF output has matching circuitry for use in 50 ohm environments. The backside of the chip is both RF and DC ground. This helps simplify the assembly process and reduces assembly related performance variations and cost.

Features

High Efficiency: 11% @P_{-1dB} Typical

Output Power, P_{-1dB} : 18dBm Typical

High Gain: 14 dB Typical

Flat Gain Response : +/- 0.5 dB Typical

Low Input/Output VSWR: <1.7:1 Typical

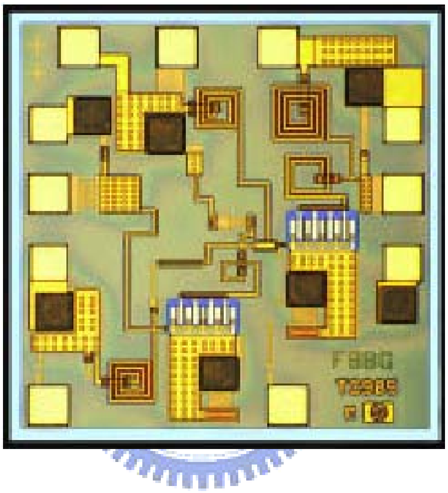


Figure 3.1 HMMC-5618

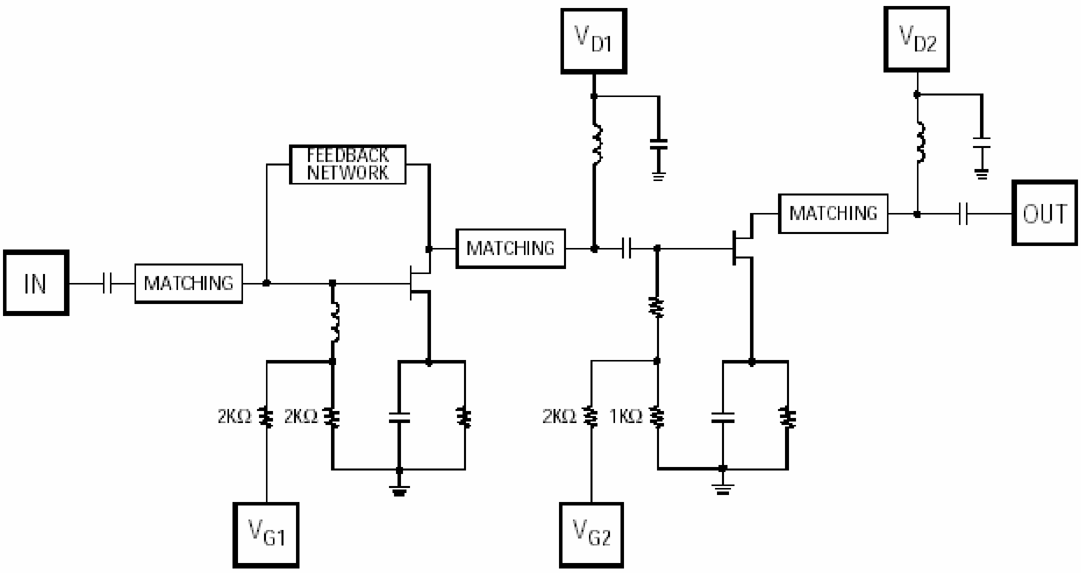


Figure 3.2 Simplified Schematic Diagram

It is recommended that the RF input, RF output, and DC supply connections be made using 0.7 mil diameter gold wire. The device has been designed so that optimum performance is realized when the RF input and RF output bond-wire inductance is approximately 0.2 nH as demonstrated in Figure 3.3. Figure 3.4 3.5 3.6 show the performance.

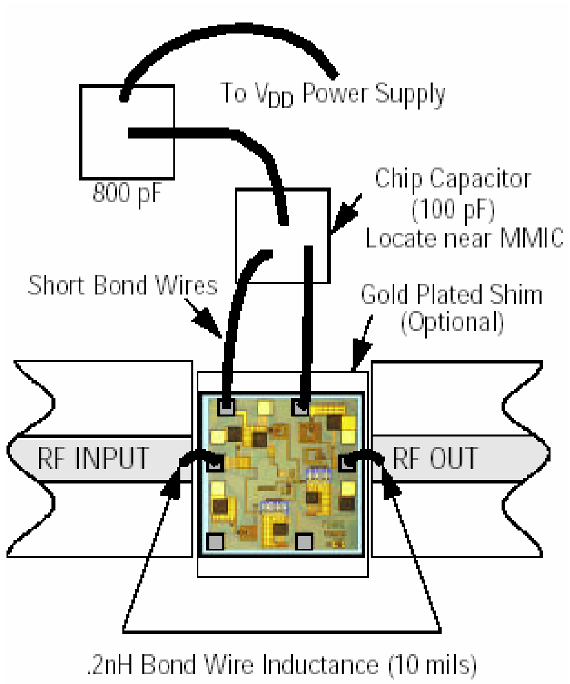


Figure 3.3 Assembly for single drain_bias operation

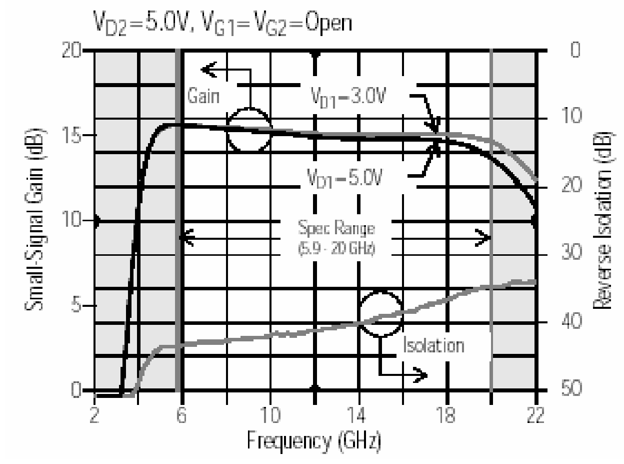


Figure 3.4 Gain and Isolation versus Frequency

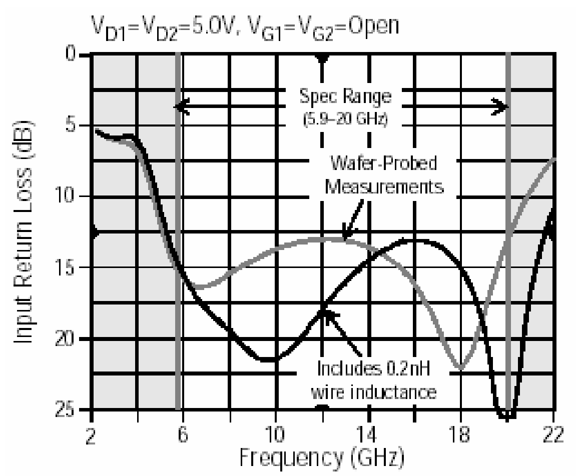


Figure 3.5 Effects of Input/Output Bond Wire

Inductance on Input Return Loss

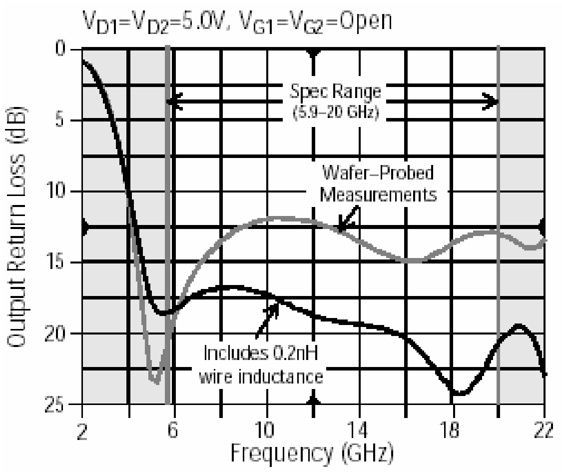


Figure 3.6 Effects of Input/Output Bond Wire Inductance on Output Return Loss

3.3 Surface Lange coupler using wire bonds in air

The Lange coupler is the best known and widely used 90-hybrid structure. Julius Lange originally proposed the Lange coupler configuration in 1969 [10]. It typically finds application in balanced designs, such as, balanced amplifiers, mixers, and modulators. I apply the proposed technique and use it in the design of 4-element Lange coupler. Using ref.[11], 3-dB coupling from a 4-element coupled line structure.

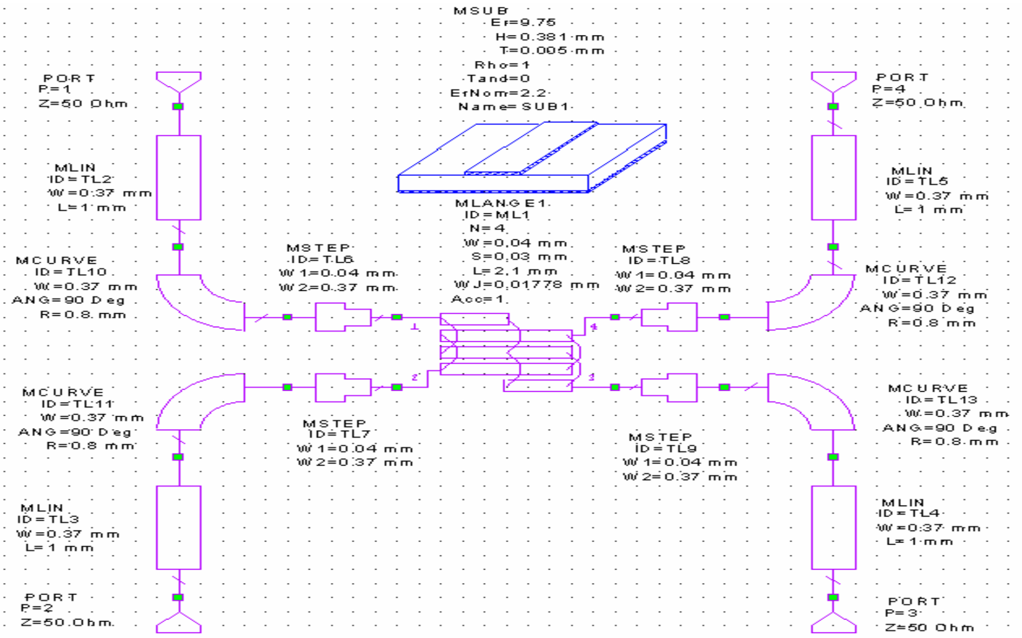
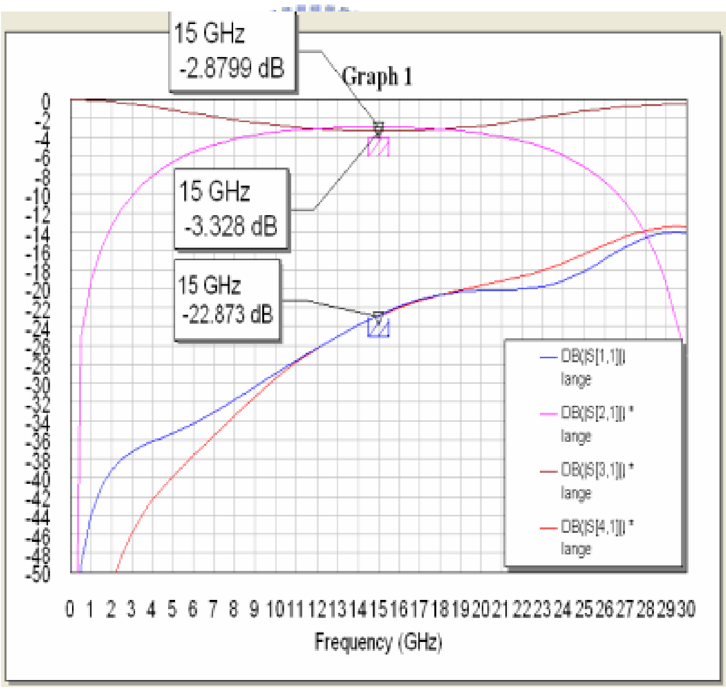


Figure 3.7 Lange coupler schematic



S11/S41 : -22.9dB@ 15GHz

S21: -2.9dB@ 15GHz

S31: -3.3dB@ 15GHz

Figure 3.8 Simulation result (S11/S21/S31/S41)

3.4 Balance amplifier

The LP750 is an Aluminum Gallium Arsenide / Indium Gallium Arsenide (AlGaAs/InGaAs) Pseudomorphic High Electron Mobility Transistor (PHEMT), utilizing an Electron-Beam direct-write 0.25 um by 750 um Schottky barrier gate. The recessed “mushroom” gate structure minimizes parasitic gate-source and gate resistances. The epitaxial structure and processing have been optimized for reliable high-power applications. The LP750 also features Si3N4 passivation and is available in a variety of packages.

Figure 3.9 shows the single device schematic. The S11 parameter is –6.9dB as shown in Figure 3.10.

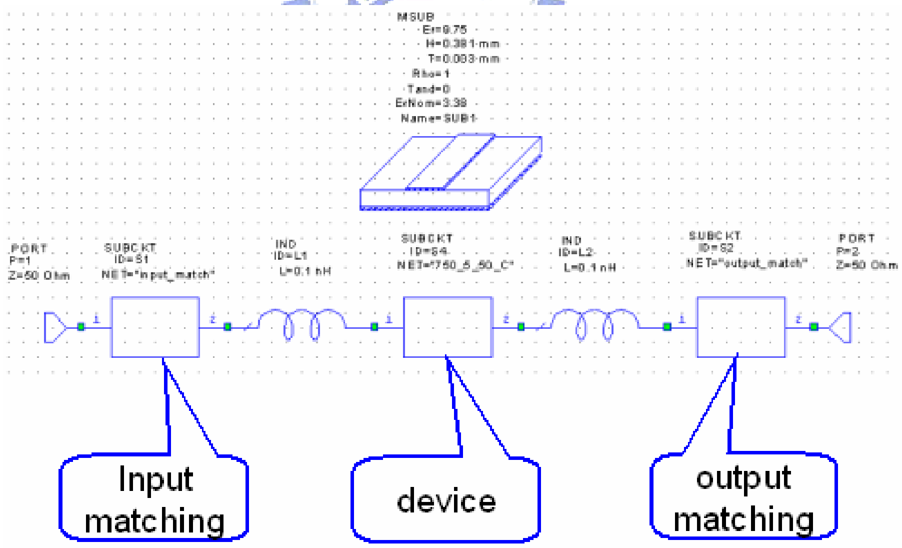
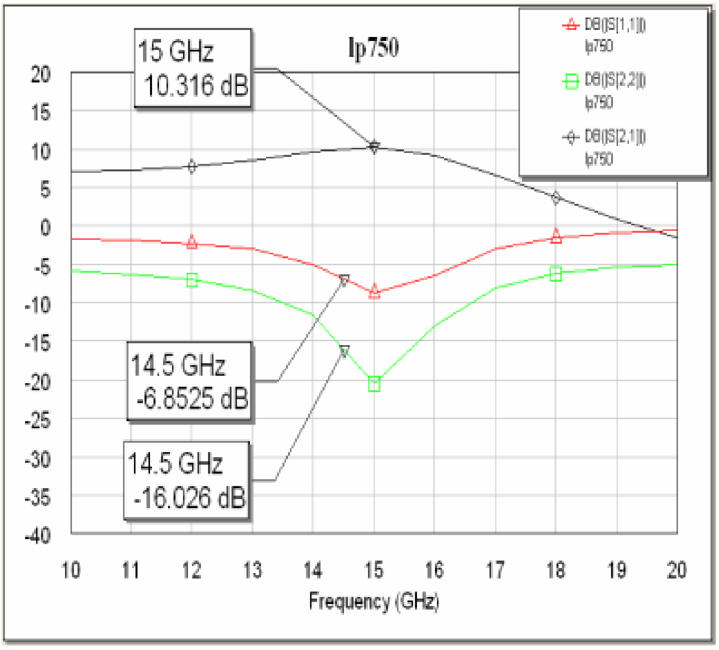


Figure 3.9 Single LP750 amplifier schematic



S11: -6.9 dB@ 14.5GHz

S21: 10.3 dB@ 15GHz

S22: -16 dB@ 14.5GHz

Figure 3.10 Simulation result (S11/S21/S22)

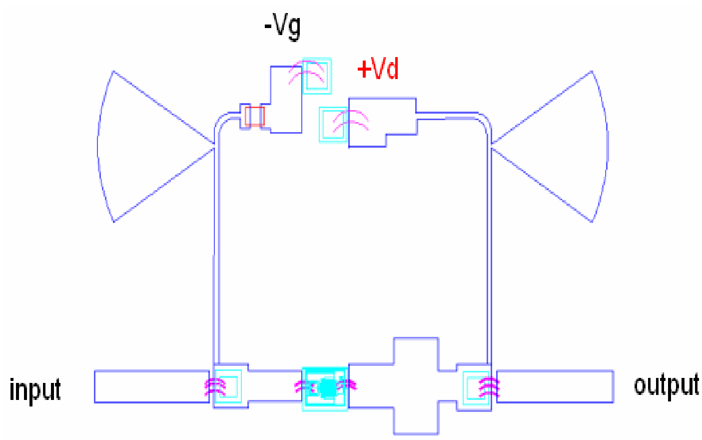


Figure 3.11 Single PA layout pattern

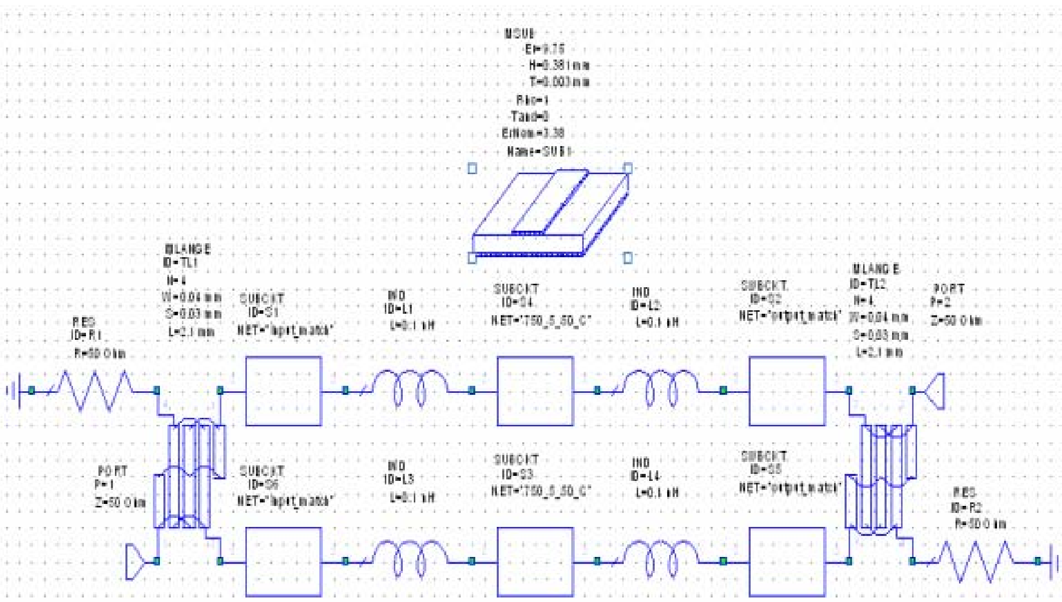
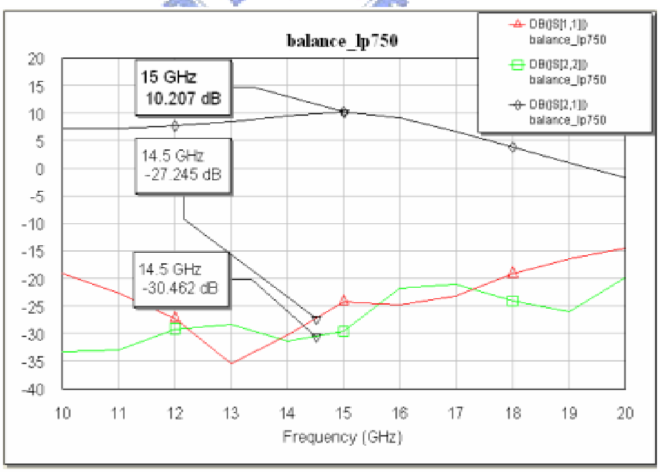


Figure 3.12 Balance amplifier schematic

Figure 3.12 shows the balance amplifier. The amplifier consists of two lange coupler. The isolation port of lange coupler is terminal 50 ohm. Figure 3.13 shows the perfect input and output return loss.



S11: -27.2 dB@ 14.5GHz

S21: 10.2 dB@ 15GHz

S22: -30.5 dB@ 14.5GHz

Figure 3.13 Simulation result (S11/S21/S22)

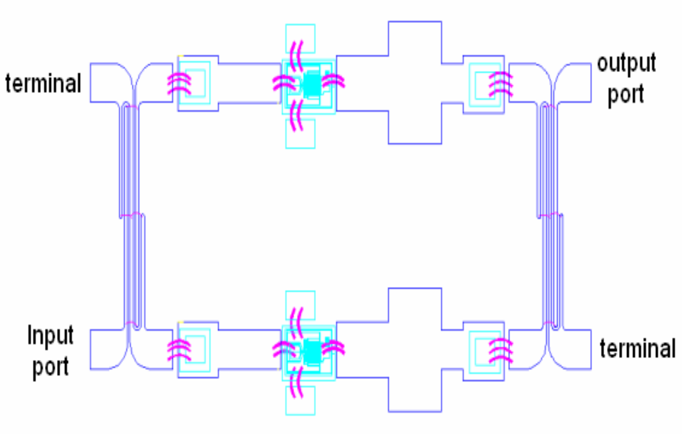


Figure 3.14 balance PA layout pattern

3.5 Zig-Zag coupler

The RF character of the normal coupler line is not good as shown in Figure 3.15. . I choose the Zig-Zag coupler to improve the return loss、 isolation and coupling loss. The software tool uses the Microwave Office.

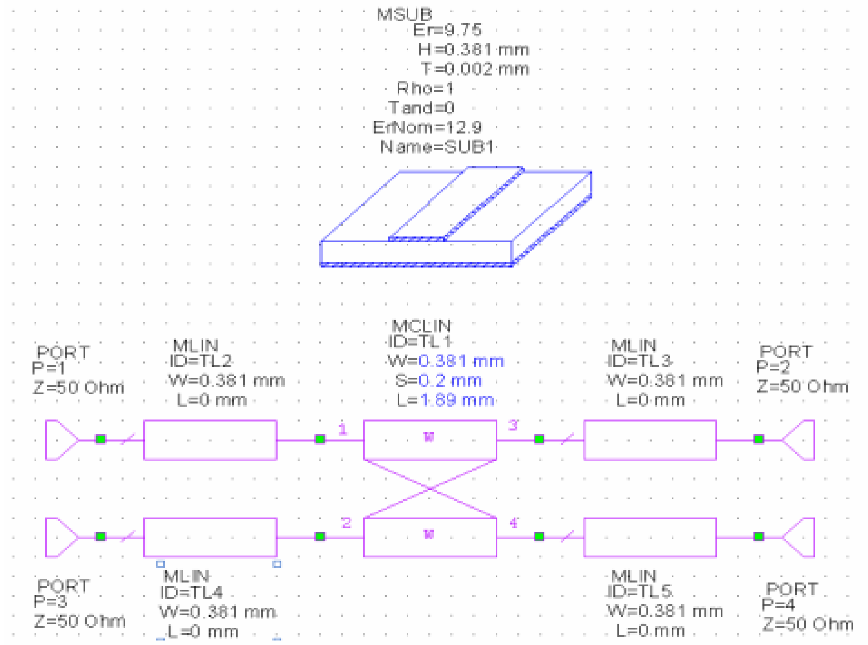
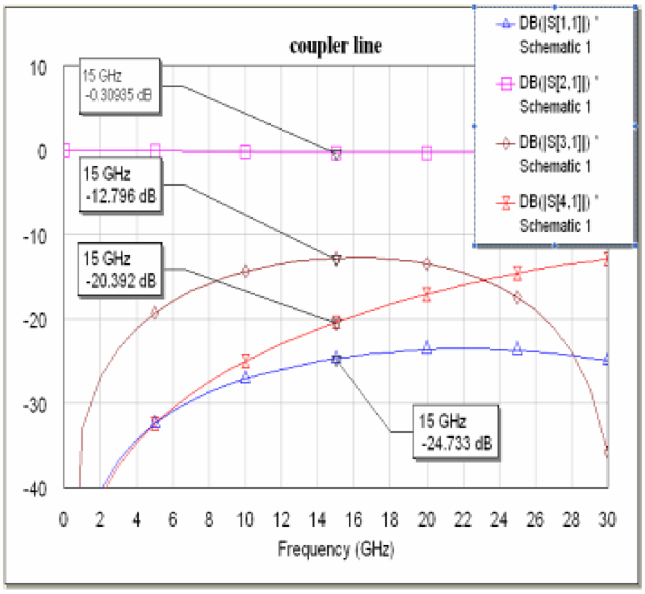


Fig 3.15 The normal coupler schematic



S11: -24.7 dB@ 15GHz

S21: -0.3 dB@ 15GHz

S31: -12.8 dB@ 15GHz

S41: -20.4 dB@ 15GHz

Fig 3.16 **Simulation result (S11/S21/S31/S41)**

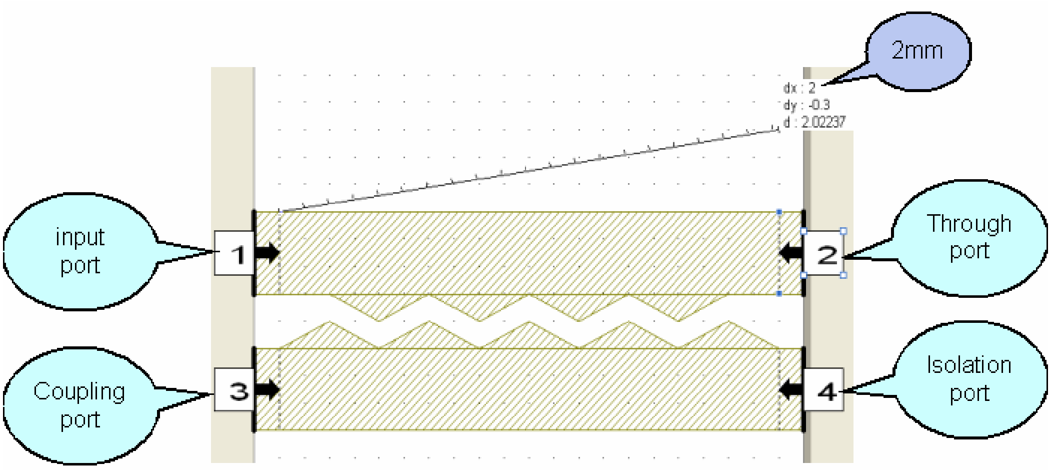


Figure 3.17 Zig-zag coupler

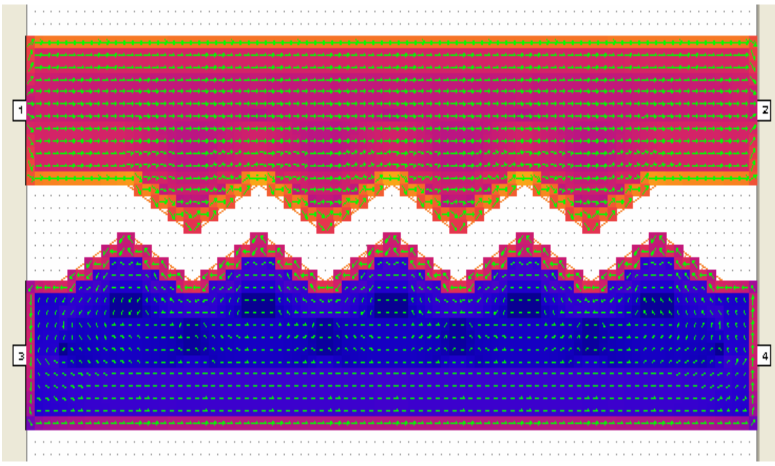
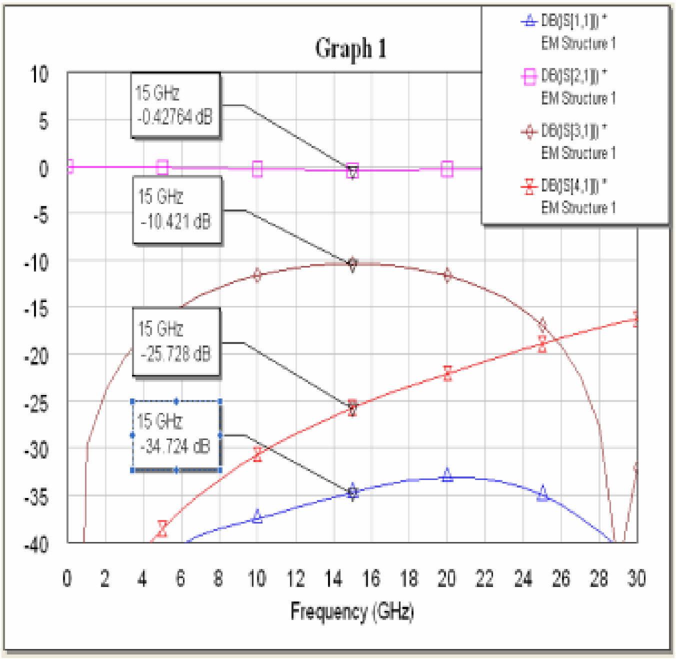


Figure 3.18 EM simulation (software tool use Microwave Office)



S11: -34.7 dB@ 15GHz

S21: -0.4 dB@ 15GHz

S31: -10.4 dB@ 15GHz

S41: -25.7 dB@ 15GHz

Figure 3.19 Simulation result (S11/S21/S31/S41)