A BROADBAND MICROWAVE AMPLIFIER USING MULTILAYER TECHNOLOGY

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ABSTRACT

In this paper, we propose a new broadband microwave amplifier structure using multi layer technology. Thus the design of multilayer interconnections, with combined slotlines and microstriplines, improves the integration of a feedback passive cell and permits to obtain a broadband balanced amplifier without increasing the circuit area. A first part details the structure design and the conception of this feedback cell. In a second part, the method is performed for a microwave amplifier design considering a GaAs FET commonly used in microwave circuits. A large frequency bandwidth of about 500MHz around 4 GHz is obtained. The results concerning the input VSWR, the output one and the gain are then presented. In conclusion the amplifier performances are satisfying and the feasibility of such a structure with the use of the multilayer interconnections is then evidenced.

INTRODUCTION

The recent development in microwave system, in particular for wireless and mobile communications applications are increased. There is a need of higher integration density both with low cost requirements. The multi layer technologies with the advances in plastic printed circuits and ceramic hybrids offer a good solution to achieve these goals. In this paper we describe a broadband amplifier structure using GaAs FET with an original balancing feedback cell based on multi layer interconnections.

DESIGN AND MODELING

The amplifier is made with a GaAs FET commonly used in microwave circuits with a 500MHz frequency bandwidth around 4 GHz. As the Rollett's factor K of this component is less than 1 for f < 4.4 GHz, the unconditional stability is not achieved in the frequency bandwidth, so a balancing network becomes necessary to improve this stability. In order to achieve this goal, we propose a multi layer planar structure using both slot and microstrip lines (see figure 1 and 2). The grid and drain access lines are coupled by two slot lines to a microstrip printed on the opposite side of the multi layer substrate.

Taking into account the respective capacitive and inductive end effects of opened and shortened microstrip and slotline [2], [3], [4], it can be shown that this cell operates as a classic RLC circuit between drain and grid access. This method improves the integration of the feedback passive cell and permits to obtain a broadband balanced amplifier without increasing the circuit area. Depending on physical characteristics (different layer thickness', dielectric substrate permittivity and conductivity of the different conductive layers), the geometrical parameters (width, length line, coupling distance …) are determined by using our own specially developed CAD software [5], and the structure design is achieved. The global amplifier structure is then simulated using ADS software and its component library.

RESULTS AND DISCUSSION

The method has been performed considering alumina dielectric substrates (εr =9.9, h = 635 µm), with screen-printed gold ink for the conductive layers, and a GaAs FET referenced MGF1601B. The successive simulations lead to the optimized geometrical parameters given table 1.
On the figure 3, the data present the Rollett's factor K (versus frequency) for the FET alone and with its stability feedback circuit. Then the global layout of the amplifier could be drawn with the stability feedback structure, classical input and output matching cells and polarization access like shown on the figure 4. And the simulation was leaded.

The simulated results for the global amplifier structure are presented figure 5 for the input and output VSWR, and figure 6 gives the amplifier transmission response. The output VSWR is less than 1.3 on the 500MHz bandwidth around 4GHz. In order to perform the gain ripple in the bandwidth, the input is slightly unmatched with an accepted VSWR higher than 2 for the lower frequencies.

A good achievement is obtained in the 500 MHz considered frequency domain around 4 GHZ. With 14.3dB for the gain value and a ripple less than 0.1 dB, the amplifier performances are satisfying.

CONCLUSION

In conclusion, this paper presents a broadband amplifier. This is performed by the use of a GaAs FET with a mixed slot line – microstrip line multilayer feedback circuit to obtain the unconditional stability in the frequency domain (3.7 – 4.2 GHz). It is obvious that this principle can also be used for different RF devices and substrates such as co-fired ceramic. The feasibility of such a structure and the use of the multilayer interconnections are then evidenced. It offers an integration density improvement for the microwave system design.

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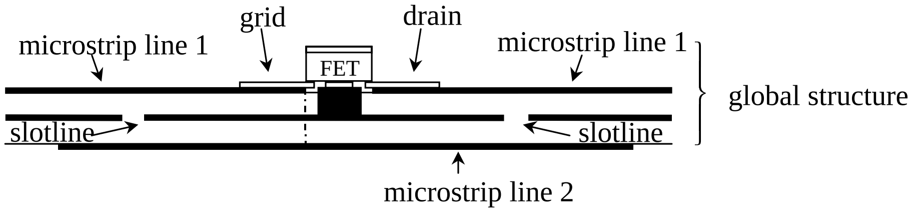

Figure 1: Amplifier structure design

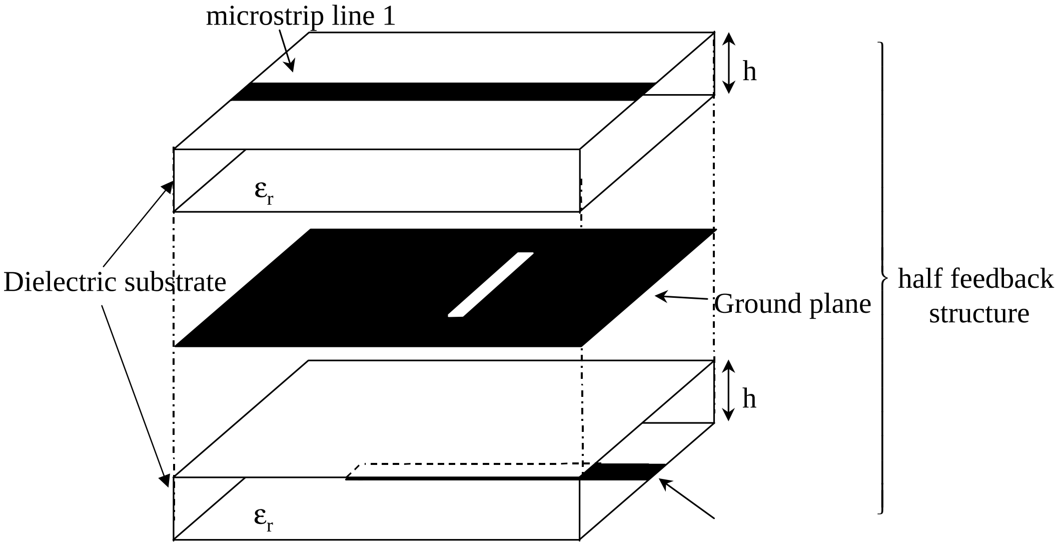

Figure 2: Feedback cell topology

Feedback microstrip line	Length = 18.5 mm Width = 600µm
Slot lines	Length = 4.4 mm Width = 200µm

Table 1: Optimized geometrical parameters

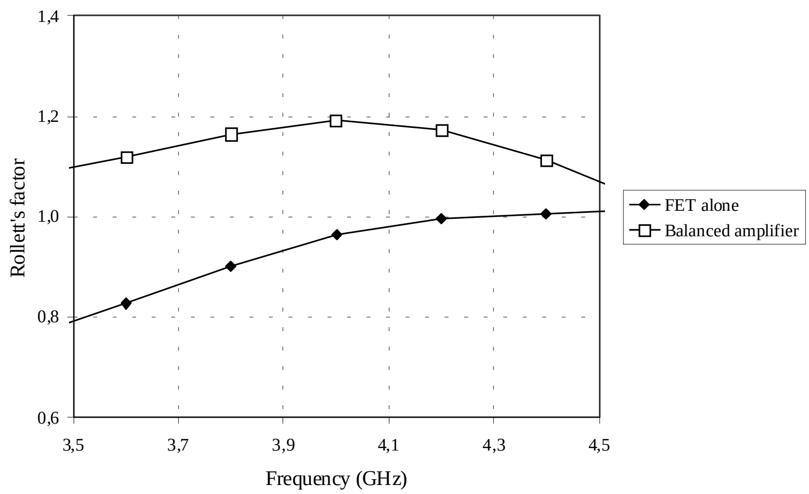

Figure 3: Rollett's factor

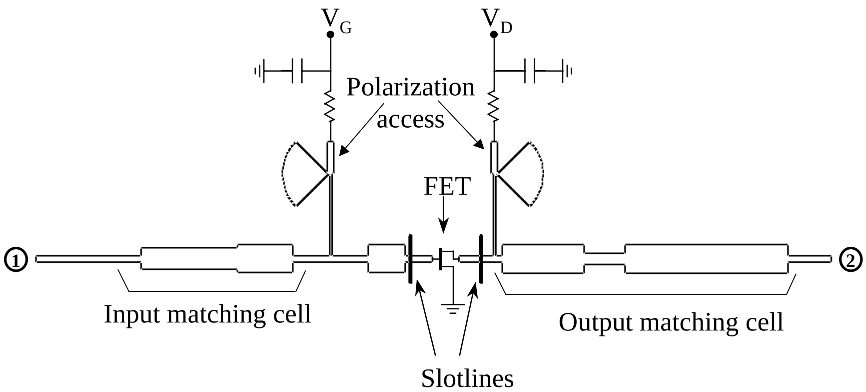

Figure 4: Global amplifier layout

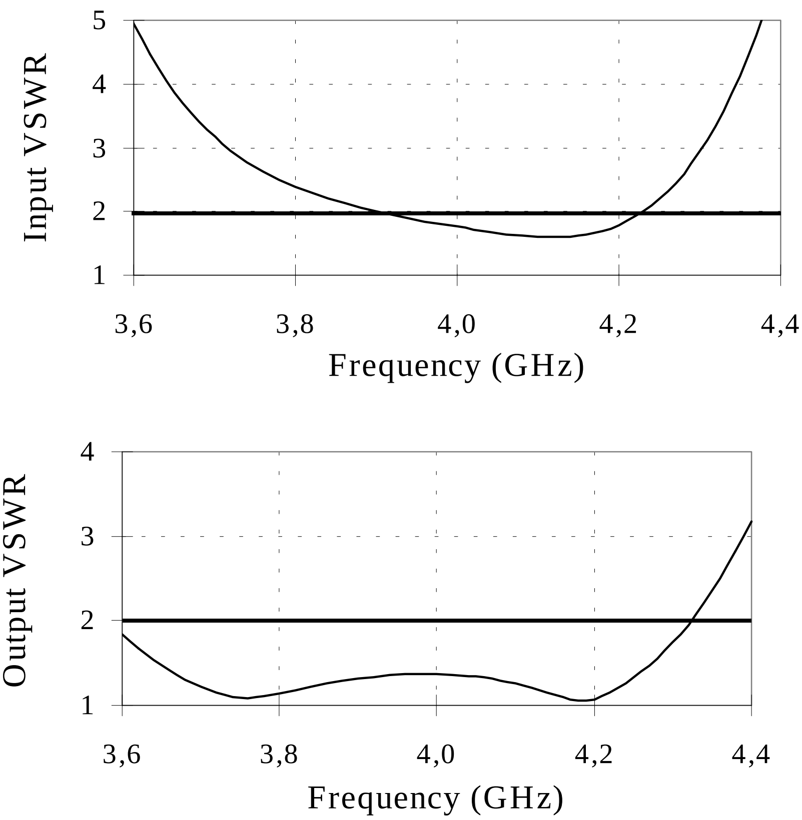

Figure 5: Input and output VSWR

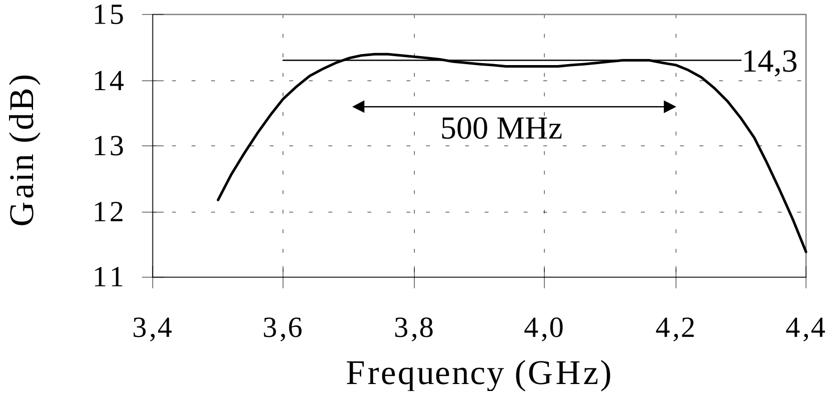

Figure 6: Transmission response