A SUSPENDED STRIPLINE TO MICROSTRIP TRANSITION USING MULTILAYER TECHNIQUES

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ABSTRACT

A suspended stripline to microstrip transition using multilayer techniques is investigated theoretically and experimentally. With this transition the advantages of both transmission line types can be combined in one integrated circuit. Coupling of the lines is obtained by overlapping of the suspended stripline and the microstrip line placed on different sides of a common substrate. The transition is analysed using a spectral domain approach and resonance techniques. The calculation method is verified by comparison of calculated and measured results.

INTRODUCTION

Planar multilayer structures offer the possibility to combine several types of microwave transmission lines in one circuit. In that way the advantages of different transmission lines can be combined. Accordingly, these transmission lines have to be connected by suitable transitions. Such transitions can be used as matched connections or as matching or filter elements. Some examples have already been reported, e.g. [1], [2]. A very promising arrangement is the combination of suspended stripline with microstrip. Suspended stripline has considerably smaller losses than microstrip and is better suited for high-Q resonators and filters, for example [3], [4]. On the other hand, microstrip offers advantages for circuits including (integrated) semiconductor devices, especially when direct ground connections and a suitable heat sink are required. Employing simple integrated transitions between both types of lines, as is indicated in Fig. 1, the advantages of both can be combined.

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CONFIGURATION AND ANALYSIS OF THE TRANSITION

The configuration of the transition is shown in Fig. 2. The microstrip line is placed on the topside of the substrate. Suspended stripline and microstrip ground are placed on the backside. Coupling is obtained by overlapping of the suspended stripline and the microstrip line. This arrangement does not only provide the transition between the two types of transmission lines, but also gives a DC isolation which may be of great importance concerning active circuits. For the analysis of the transition a field–theoretical method based on a spectral domain approach and resonance techniques [5] is used. Within this procedure, the currents on the transmission line strips as well as on the microstrip ground are represented by suitable expansion functions including edge terms at the open sides of the metallisation. In this way the complex scattering matrix of the transition can be calculated. The properties of the transition depend particularly on the overlapping length d and the gap width g (Fig. 2) between suspended stripline and microstrip ground.

RESULTS

Fig. 3 shows the calculated transmission coefficient as function of the overlapping length d and the gap width g for 10 GHz. The characteristic impedance of the suspended stripline and microstrip is 100 Ω and 50 Ω, respectively. These results show a relatively weak dependence on both the overlapping length and the gap width.
To verify the calculation method, a 50 Ω microstrip resonator coupled to 100 Ω suspended stripline on both ends (Fig. 4) was fabricated and measured. The theoretical results of the resonator structure were calculated including a typical loss of the microstrip line of 0.1 dB per wavelength. Measured and calculated reflection and transmission coefficients versus frequency are compared in Fig. 5. A very good agreement between theoretical and experimental results can be stated.
Finally, a single 100 Ω suspended stripline to 50 Ω microstrip transition was fabricated and tested. The 100 Ω suspended stripline was connected to the 50 Ω measurement system by a 40 mm long tapered line. Fig. 6 shows the measured reflection and transmission coefficients as function of frequency in comparison to calculated results. Once again, theory and experiment agree very well. A slight ripple in the measured results is due to an imperfect transition from coaxial line microstrip with 254μm substrat height only.

CONCLUSION

All these results show that this type of transition has a broadband performance, and the dependence on geometrical dimensions is not very critical. In this way, broadband matched transitions can be realised. On the other hand, with a reduced overlapping length of the lines, weak coupling to the first resonator of a filter, for example, is possible, too.

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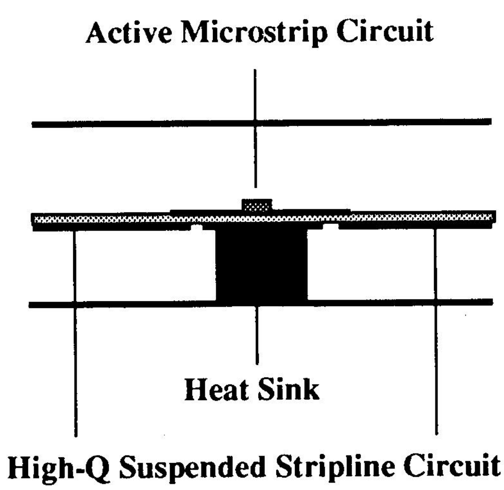

Figure 1: Proposed combination of suspended stripline and microstrip circuits

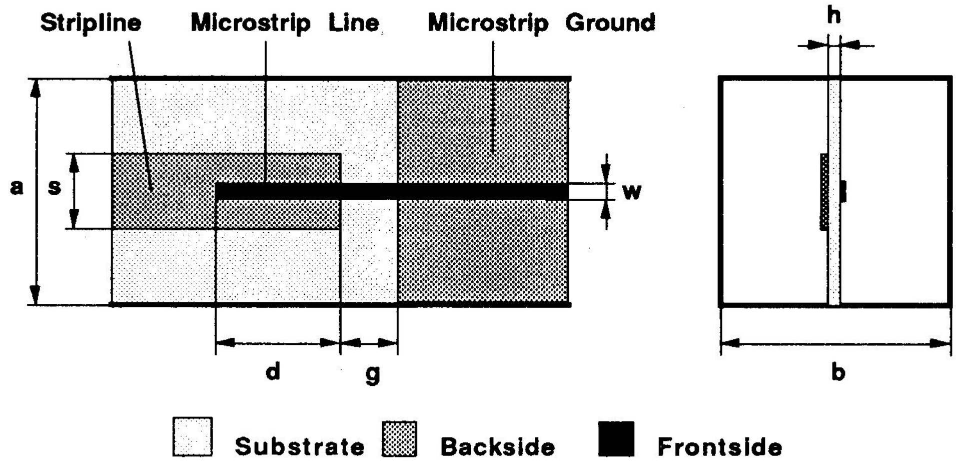

Figure 2: Configuration of the suspended stripline to microstrip transition

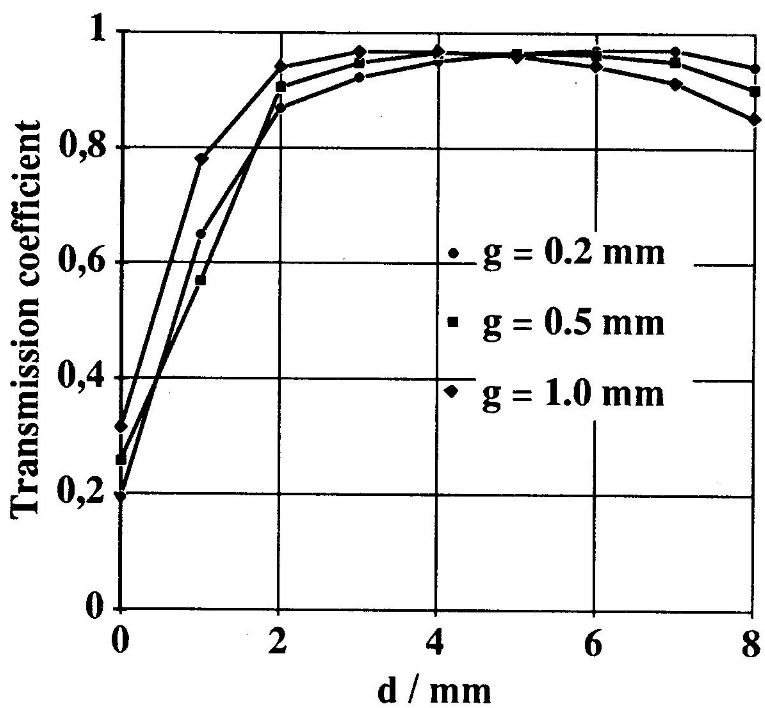

Figure 3: Calculated transmission coefficient of a single transition: $\epsilon_r = 2.22$, $h = 0.254mm, a = b = 5.0mm, w = 0.76mm, s = 1.75mm, f = 10GHz$

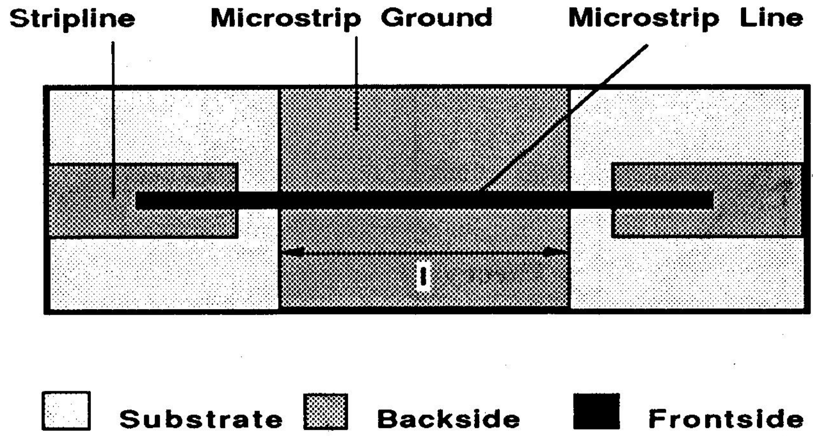

Figure 4: Microstrip resonator coupled to suspended stripline

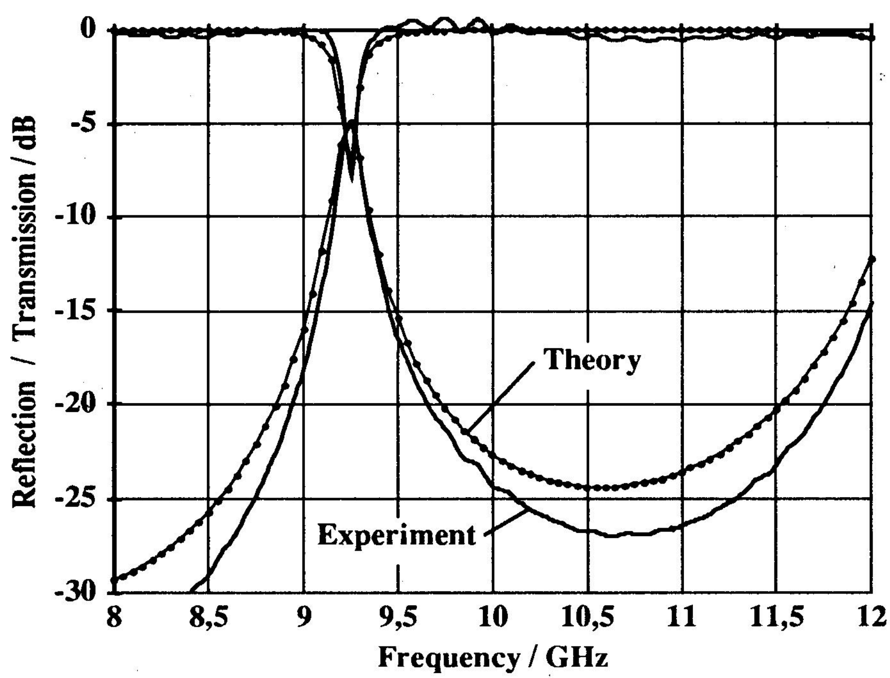

Figure 5: Measured and calculated reflection and transmission of a coupled microstrip resonator: $\epsilon_r = 2.22, h = 0.254mm, a = b = 5.0mm, w = 0.76mm, s = 1.75mm, g = 1.0mm, d = 0.0mm, l = 46.73mm$

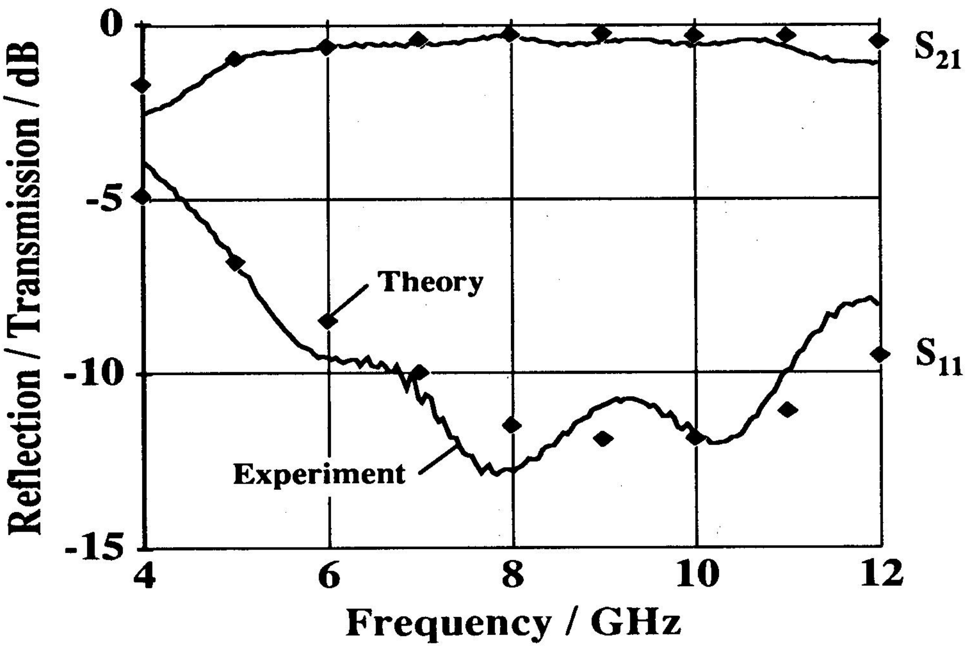

Figure 6: Measured and calculated reflection and transmission of a single transition: $\epsilon_r = 2.22, h = 0.254mm, a = b = 5.0mm, w = 0.76mm, s = 1.75mm, g = 1.0mm, d = 4.0mm$