A Wideband Coplanar Stripline to Microstrip Transition

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***Abstract*—A wideband coplanar stripline (CPS)-to-microstrip line was developed. The transition has a simple structure for the ease of fabrication with low cost. The measured performance of two back-to-back transitions exhibits an insertion loss of less than 3 dB and a return loss of better than 10 dB over a bandwidth from 1.3 GHz to 13.3 GHz (1 : 10.2). For narrower bandwidth, an insertion loss of less than 1 dB with a return loss of better than 10 dB was achieved from 1.4 GHz to 7.3 GHz (1 : 5.2).**

***Index Terms*—Balun, coplanar stripline (CPS), CPS-to-microstrip transition, transition, wideband transition.**

I. INTRODUCTION

COPLANAR STRIPLINE (CPS) is a uniplanar transmission line structure which finds good applications in feeding printed dipole antennas and mounting solid-state devices without via holes. The advantage of CPS over coplanar waveguide (CPW) is that CPS has less metal compared to CPW and correspondingly can efficiently utilize the substrate area.

Various methods of designing CPS-to-microstrip transitions have been reported. In [1], Dib *et al.* reported a type of uniplanar transitions based on the concept of mode conversion with a 3 dB back-to-back insertion loss bandwidth from 7 GHz to 11.5 GHz (1 : 1.6) for the CPS-to-microstrip transition. In 1997, Qian and Itoh [2] improved the performance with a 3 dB back-to-back insertion loss bandwidth from 6 GHz to 13 GHz (1 : 2.1) by employing symmetric T-junction for the structure of [1]. Simons *et al.* [3] also proposed a transition using a coupling method with a 2.4 dB back-to-back insertion loss bandwidth from 5.1 GHz to 6.1 GHz (1 : 1.2). However, this design used a CPS-to-microstrip-to-CPS back-to-back structure and required special CPS TRL (through-reflect-line) on-wafer calibration standards with the National Institute of Standards and Technology (NIST) de-embedding software program for a network analyzer calibration [4]–[6]. Most of these CPS-to-microstrip transitions used high dielectric constant substrate $(\varepsilon_r > 10)$ to reduce the CPS characteristic impedance [1]–[3].

CPS-to-CPW transitions have also been developed with wider reported bandwidth. Tilley *et al.* [7] presented a wideband CPS-to-CPW transition with 1 dB back-to-back insertion loss from 0.45 GHz to 5 GHz (1 : 11). Li *et al.* [8] proposed a CPS-to-CPW back-to-back transition with the bandwidth ranging from 0.4 GHz to 3.6 GHz (1 : 9) by using Chebyshev multisection impedance transformers in the CPW transmission line. Mao *et al.* [9] demonstrated a CPS-to-CPW transition operating up to 20 GHz with an insertion loss of less than 0.5 dB and a return loss of better than 10 dB.

This letter presents a wideband CPS-to-microstrip transition operating from 1.3 GHz to 13.3 GHz (1 : 10.2) with an insertion loss of less than 3 dB and a return loss of better than 10 dB for back-to-back transition. It is simple and can be easily fabricated using a low dielectric constant substrate $(\varepsilon_r = 2.33)$. A microstrip-to-CPS-to- microstrip back-to-back structure has been fabricated for easy measurement with the conventional network analyzer.

II. DESIGN AND FABRICATION

The structure of back-to-back CPS-to-microstrip transition is illustrated in Fig. 1. The circuit simulation was accomplished with the aid of IE3D software, which uses the method of moment algorithm for full wave electromagnetic simulation [10]. RT/Duroid 5870 is used as the substrate with a dielectric constant of 2.33 and a thickness of 20 mil. The gap between CPS strips is 0.6 mm and the strip width is 1.5 mm. The CPS characteristic impedance is 184 Ω, as was simulated with IE3D. The microstrip line's width and length are 1.3 mm and 40 mm, respectively. The radial stub's radius is designed as 5.5 mm for broadband operation. Electric field of CPS lines is formed across the two strip lines and on the contrary, electric field of microstrip line is formed normal to the substrate. Hence, the radial stub is rotated with an angle ϕ to change electric field orientation from parallel to vertical against the substrate. The rotation angle, ϕ , is optimized as 30° for good coupling. The high characteristic impedance of CPS, 184 Ω, can be transformed to the microstrip line's 50 Ω by a smooth insertion of the ground plane toward the microstrip line. Since it does not employ any quarter wavelength transformer, which limits the bandwidth as seen in other methods [1], [2], wideband performance is achieved.

III. TRANSITION PERFORMANCE

The return loss and insertion loss of two back-to-back transitions were measured using an HP8510B network analyzer. The measured return and insertion loss of back-to-back transition excluding the SMA connector loss are illustrated in Fig. 2.

The measured 3 dB insertion loss bandwidth of back-to-back transition is from 1.3 GHz to 13.3 GHz (1 : 10.2) with a return loss of better than 10 dB. The 1 dB insertion loss bandwidth for back-to-back transition is from 1.4 GHz to 7.3 GHz (1 : 5.2).

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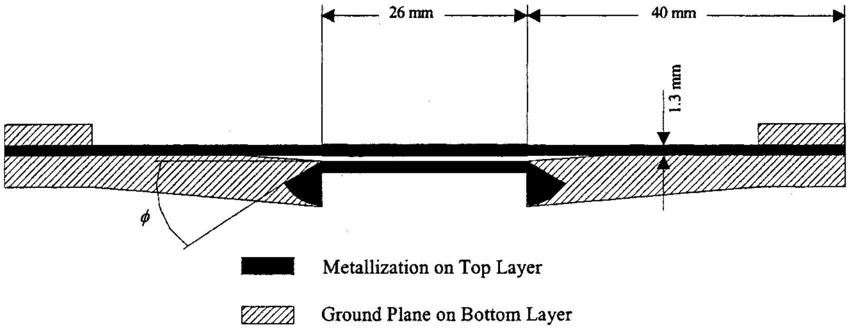

Fig. 1. CPS-to-microstrip back-to-back transition structure.

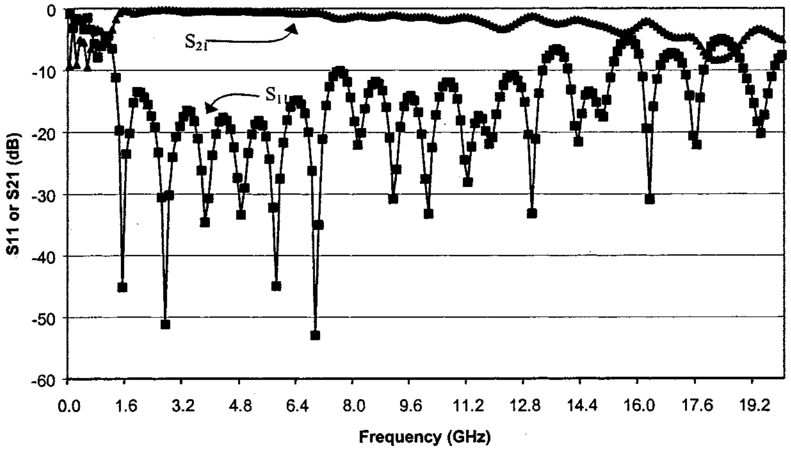

Fig. 2. Measured return and insertion loss of the back-to-back transition.

For an insertion loss of less than 0.5 dB for the back-to-back transition, the bandwidth ranges from 1.5 GHz to 6 GHz (1 : 4) with a return loss of better than 10 dB.

IV. CONCLUSIONS

A simple and low cost CPS-to-microstrip transition was designed and measured. Performance results for the back-to-back transition with less than 10 dB return loss and less than 3 dB, 1 dB, and 0.5 dB insertion losses were achieved over 1.3 GHz–13.3 GHz (1 : 10.2), 1.4 GHz–7.3 GHz (1 : 5.2), and 1.5 GHz–6 GHz (1 : 4), respectively. The transition should have many applications for feeding printed dipole antennas, and integration with MIC or MMIC passive or active devices.

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