INTERNATIONAL JOURNAL OF MICROWAVE AND OPTICAL TECHNOLOGY,

VOL. , NO. , MONTH 2007

Low-Loss Doubly Metalized CPW Low-Pass Filter with Additional Transmission Zeroes

Atallah Balalem[1], Jan Machac[2], Wong Kim-Fai[3], Abbas Omar[1]

[1]Chair of Microwave and Communication Engineering, University of Magdeburg, 39016 Magdeburg, Germany
[2]Fuculty of Electrical Engineering, Czech Technical University, 16627 Prague, Czech Republic
[3]Dfaculty of Engineering, university of Macao, Macao, China

Abstract- **This paper the classical CPW low-pass filter to doubly metalized CPW , by implementing metallic patches at the backside of the substrate. Moreover, transmission zeroes are introduced by using single, dual, and tri-resonant stubs. These stubs are built on the rear side of the substrate. The filters are compact in distinction to the standard CPW low-pass filter, and has very low-losses competed to some other structures.**

Index Terms- **Douly metalized lines, CPW Filter, low-pass filter, dual-resonant stub, tri-resonant stub.**

I. INTRODUCTION

Doubly metalized lines have proven to be an excellent technology for filter applications, [1]-[3]. Making the use of both sides of a substrate high capacitive coupling can be achieved [1], [3]. An ultra-wideband microstrip bandpass filter has been designed by using the broadside coupling between a multi-mode resonator and I/O microstrip ports [1]. Very compact quasi-lumped bandpass filters have been introduced for microstrip and CPW in [3]. Earlier, a microstrip low-pass filter has been designed using the same technology [2]. Fig. 1 shows the cross-section of the doubly metalized line, which has been presented in [3].

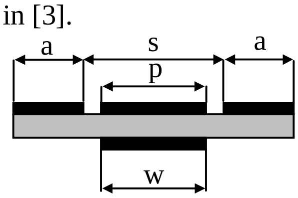

Fig. 1. Cross section of the doubly metalized CPW.

A standard CPW low-pass filter is usually designed by cascading low/high impedance sections of transmission lines. The low-impedance transmission lines represent shunt capacitances. While the high-impedance transmission lines represent series inductances, and the entire filter is built on one side of the substrate. Fig. 2 shows the layout of such a filter. Moreover, introducing of transmission zeroes for the CPW low-pass filter increases the complexity of the filter, and changes the overall filter structure. The losses are increased in majority of these structures as there are long narrow strips with high resistive impedance added to the filter [4].

This paper modifies this low loss CPW low-pass filter for doubly metalized CPW. Moreover, two, four, and six transmission zeroes are introduced to the filter response by using single-, dual-, and tri-resonant stubs. The number of the transmission zeroes is increased without increasing the size, or the complexity if the filter. All structures were simulated using the commercial MoM Simulator SONNET [5]. The filters were built on an AR600 substrate with thickness of 0.787 mm and relative dielectric constant of 6.

II. DOUBLY METALIZED CPW LOW-PASS FILTER

This paragraph shows that the impedance of the low-impedance transmission line sections can be further reduced by implementing patches on the rear side of the substrate. These patches are built under the low-impedance transmission line stubs, and are extended under the ground metalization. By this way, the shunt capacitance of the low-impedance transmission line is increased, which has main effect on reducing the filter length. Fig. 3 shows the rear side of the substrate. Whereas the topside is shown in Fig. 2. The filter has total length of about 18.7 mm, and cut-off frequency of 4.5 GHz. The simulated return and insertion loss of the filter are demonstrated in Fig. 4.

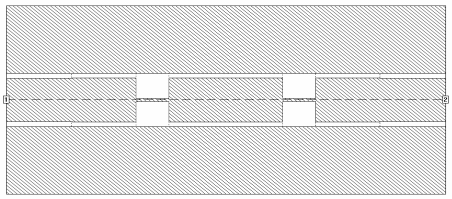

Fig. 2 Layout of the classical CPW low-pass filter.

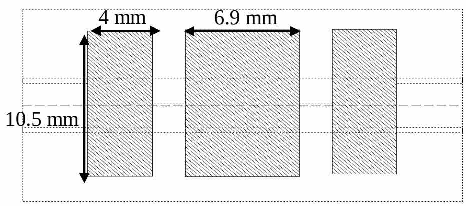

Fig. 3 Rear side metalization of the low pass filter with additional patches.

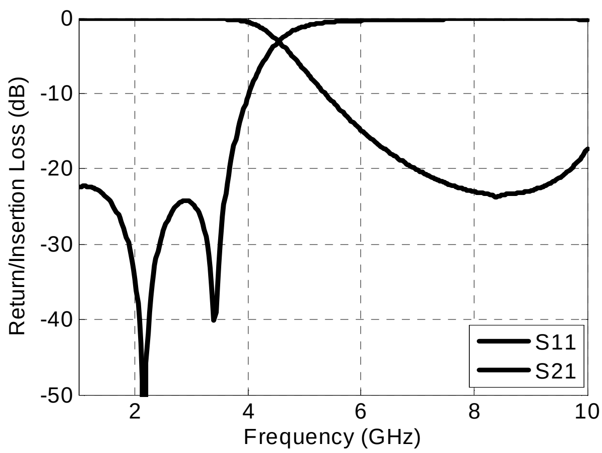

Fig. 4 Simulated Return and insertion loss of the doubly metalized CPW low-pass filter with additional patches at the back side of the substrate.

III. DOUBLY METALYED CPW LOW-PASS FILTER WITH TOW TRANSMISSION ZEROES

As it has been shown in Fig 4, the filter transmission characteristic decreases very slowly above the cut-off. Therefore transmission zeroes are needed to improve the filter response. To achieve this, the side patches were loaded by two half-wavelength stubs. These stubs are coupled capacitively to the topside ground metalization. Each of these additional stubs introduces a transmission zero to the filter response at the defined frequency. Fig. 5 shows the top and the rear side layout of the doubly metalized CPW low-pass filter with two additional stubs. Fig. 6 shows the return and insertion loss of this filter.

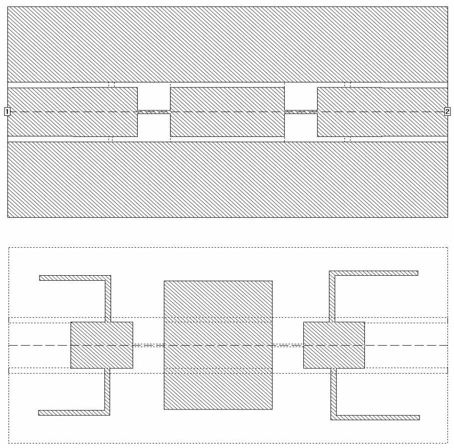

Fig. 5 Top (up) and bottom (down) layout of the doubly metalized CPW low-pass filter with single-resonant stubs.

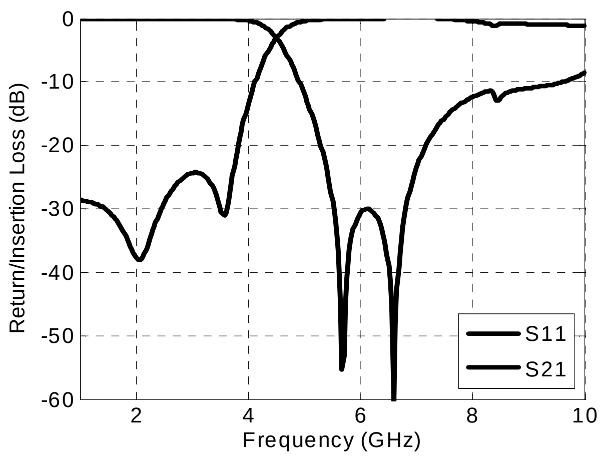

Fig. 6 Simulated return and insertion loss of the doubly metalized CPW low-pass filter with two additional transmission zeroes shown in Fig. 5.

IV. DOULBY METALIZED CPW LOW-PASS FILTER WITH FOUR TRANSMIAAION ZEROES

By adding an additional arm to the half wavelength stub, Fig. 7, we get a dual-resonant stubs and an additional resonance is generated. The mutual coupling of these two resonances is very weak. This structure suppresses better the filter transmission in the stop-band just by replacing only the side metallic patches by two dual-resonance stabs, and keeping central one as it was. Fig 7 shows the top and bottom layout if the filter, while, Fig. 8 shows its return and insertion loss. This filter has 3dB cut-off at bout 4.3 GHz, and four transmission zeroes are generated at about 5.7, 6,2, 6.8, and 7.6 GHz respectively. The insertion loss at the passband is 0.2 dB. The filter works well up to 8 GHz. A very good agreement between the simulated and the measured data is achieved except small shift in the transmission zeroes, which most properly caused by some fabrication errors.

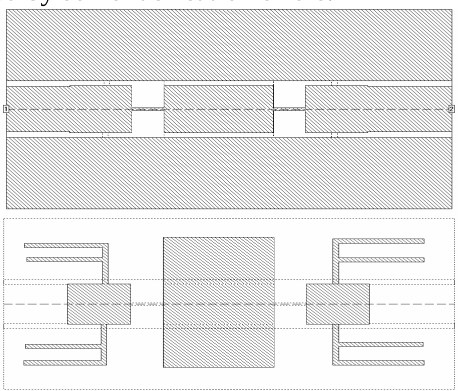

Fig. 7. Top (up) and bottom (down) layout of the doubly metalized CPW low-pass filter with dual-resonant stubs.

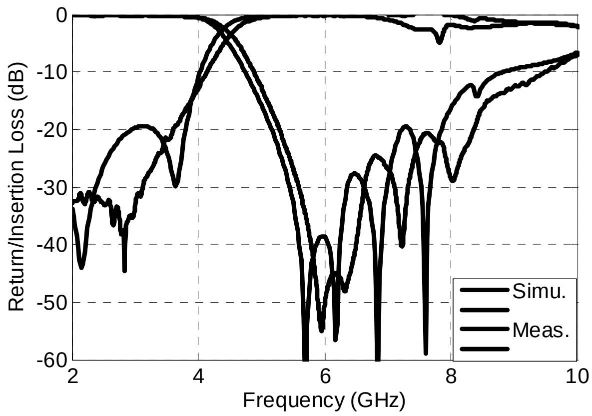

Fig. 8 Return and insertion loss of the doubly metalized CPW low-pass filter with four additional transmission zeroes.

V. DOULBY METALIZED CPW LOW-PASS FILTER WITH SIX TRANSMIAAION ZEROES

Adding the third arm to the dual-resonant stub, Fig. 9, would increase the number of transmission zeroes by one. These resonances are only weakly coupled to each other, therefore, in our design we kept the central patch unchanged, and we replaced the side patches bye the tri-resonant stubs. Moreover, the lengths of the arms were do not vary too much. Fig. 9 shows the top and bottom layouts of the filter. Fig. 10 shows the measured and simulated insertion and return loss of the filter. A good agreement was achieved except a shift in the transmission zeroes position, which occurs due to some fabrication errors.

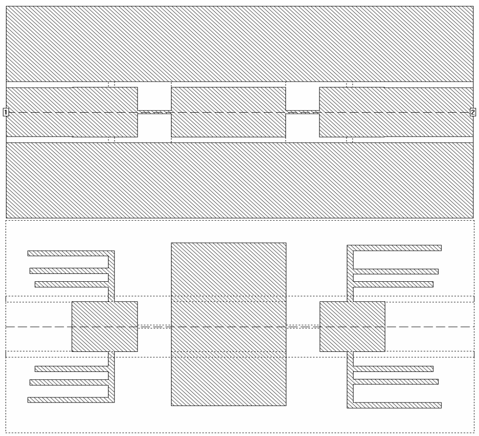

Fig. 9 Top (up) and bottom (down) layout of the doubly metalized CPW low-pass filter with tri-resonant stubs.

VI. CONCLUSION

A very compact low-loss CPW low-pass filter using a doubly metalized CPW was introduced by implementing patches on the rear side of the substrate under the low-impedance transmission line sections. Moreover, transmission zeroes were introduced to the filter resosponce by loading some on the patches by single-, dual-, and tri-resonant stubs. A good agreement between the measured and simulated results was achieved. These transmission zeros improve the rate of decrease of the filter transmission at its cut-off.

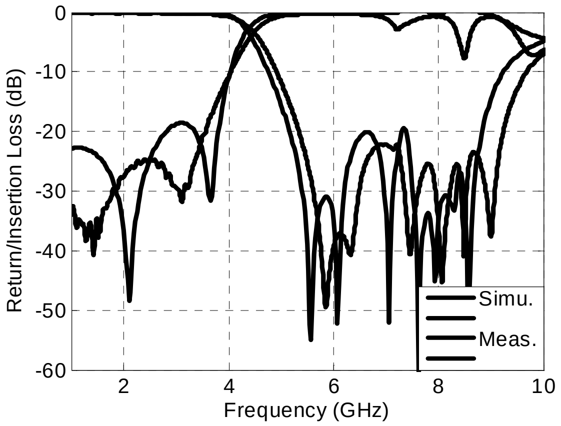

Fig. 10 Return and insertion loss of the doubly metalized CPW low-pass filter with six additional transmission zeroes.

REFERENCES

[1] H. Wang, L. Zhu, and W. Menzel, ''Ultra-Wideband bandpass filter with hybrid microstrip/CPW structure,'' *IEEE Microwave and Wireless Components Letters*, Vol. 15, No. 12, pp. 844- 846, Dec. 2005.

[2] L. Zhu, H. Bu, K. Wu, and M. Stubbs, "Unified CAD model of microstrip line with rear side aperture for multilayer integrated circuits", *2000 IEEE MTT-S Int. Microwave Symp. Dig.*, Boston, USA, pp. 981-984, June 2000.

[3] Normal + 9 pt;ItalicS. Sun, and L. Zhu, ''Compact dual-band microstrip bandpass filter without external feeds,'' *IEEE Microwave Theory and Techniques*, Vol. 15, pp. 644-646, Oct.2005.

[4] J. Sor, Y.Qian, and T. Itoh, ''Miniature low-loss slow-wave CPW Periodic structure for filter Applications,'' IEEE MTT Trans. Vol. 49, No. 12, pp. 2336-2341, Dec. 2001.

[5] SONNET, Version 10.52, Sonnet Software Inc.