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Research Article

A Compact Microstrip Planar Crossover for LTE Applications

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Abstract – Microwave integrated circuits (MICs) are becoming increasingly important in communication systems due to their ability to efficiently transfer power and signals using crossover structures. Conventional crossover designs, however, suffer from significant signal and power losses, limiting their performance. In various studies, there are complex planar designs, MICs and Radio Frequency (RF) circuits operating from frequencies and bands. This paper proposes a novel fully symmetric four-port microstrip planar crossover that overcomes these limitations. A square microstrip structure with a size of $80.0 \times 80.0 \times 1.6$ mm³ is presented in the design, which has a planar crossover and wide band gap at an operating frequency of 2.1 GHz. The proposed design provides excellent isolation between ports and minimizes signal and power losses, making it a promising solution for MICs and RF circuits for LTE applications.

Keywords –Microwave Integrated Circuits (MICs), Crossover, Radyo Frequency (RF), Microstrip Structures, LTE Applications

I. INTRODUCTION

Microwave integrated circuits (MICs) technology, which is one of the most important technologically innovative areas in power transfer and signal transfer with the help of crossover structures, is becoming one of the fastest and most innovative growing technological trends in the field of communication in addition to the conventional mm-wave components [1-5]. In parallel with the innovative developments in MICs, the use of these crossover structures is increasing, especially in structures that have two signal paths where the ports in the circuit match and overlap each other with perfect isolation. In the past, wire bond or air bridge [6-8] structures were used to allow two signals to pass each other. Considering that these structures cause significant signal and power losses and slow transmission, planar structures [9-14,17] as a new perspective have become very important. Calculated and measured values between lines and ports at the operating frequencies of Radio Frequency (RF) elements are carefully evaluated in terms of system bandwidth and lossless transmission. With the beginning of studies on structures to change the frequency range and increase the bandwidth of conventional MICs [9], there is a new interest in the design and analysis of both single and dual-band structures in these circuits and gates operating at different frequencies [7, 10-15,17].

Nowadays, with the increasing interest in planar technology, the complexity of RF circuits and MICs has increased rapidly. As a result of the innovation and diversification of high-density microwave integrated circuits and other microwave planar systems containing many components, crossovers have become important components in various microwave circuits. These microstrip planar crossovers, which are used in communication technologies today, are recommended as planar solutions due to their low profile, cheap cost, ease of production and low weight. The relatively more complex structure of a gate is an obstacle to such an effort.

With this purpose in this article proposes the fully symmetric four-port microstrip planar crossover introduced in the Fig. 1, which leads to a much-simplified analysis of the crossovers. In the crossover parameters, the insertion loss, return loss and isolation parameters measured between the ports were calculated according to the proposed symmetric structure. This structure prevents signal and power losses and provides perfect isolation. Moreover, the agreement between calculations and simulation results confirms the validity of the proposed structure for LTE applications.

Section II details the planar crossover design methodology and various parameters used in the study, while Sections III-IV show and discuss the simulation results of the designed crossover. Section V summarizes the result of the work focused on designing planar crossovers for RF circuits and MICs.

II. Materials and Method

There are various crossover designs used for RF and microwave integrated circuit systems [10-15]. In this study, a planar, single-band crossover design was designed. The proposed microstrip planar crossover was produced on FR-4 substrate with dielectric constant (ε_r), loss tangent ($tan\,\delta$) and layer thickness (h) of 4.3, 0.025 and 1.6 mm, respectively. The overall size of this crossover is $80.0 \times 80.0 \times 1.6$ mm^3.

The proposed planar crossover design includes many geometric parameters, and a connection structure is created through four ports, two of which are well isolated, including the output and input. The structure in Fig.1 was designed on CST Studio Suite through the electromagnetic (EM) simulation program and the parameters are listed in Table 1.

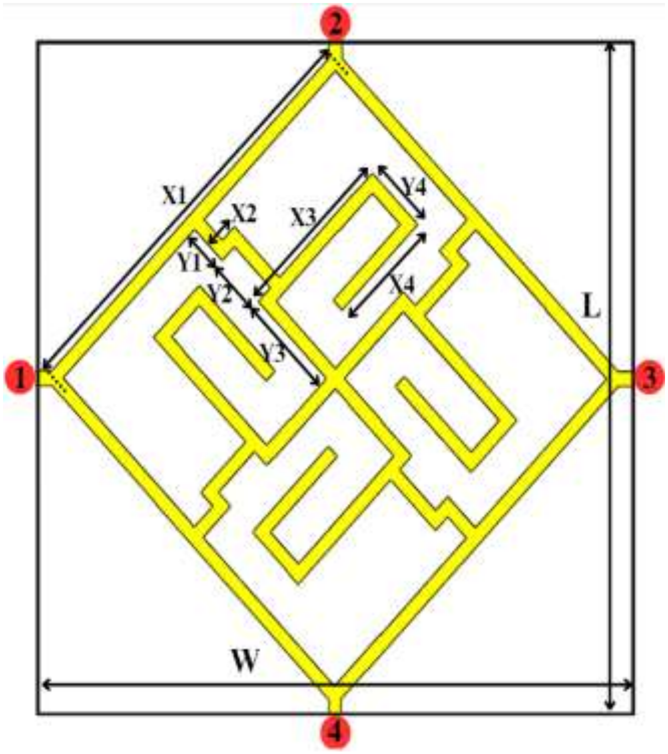

Fig. 1 Proposed planar crossover design

Table 1. Parameter of proposed planar crossover (mm)

W	X1	X2	X3	X4
80.0	52.0	3.8	20.4	13.6
L	**Y1**	**Y2**	**Y3**	**Y4**
80.0	8.1	6.5	9.8	8.2

III. Results

In planar crossover designs, frequency and band gaps are important in structures designed differently for signal and power transmission. To simulate the frequency responses, a 2.1 GHz microstrip planar crossover is numerically simulated based on the design as an example, the results of which are shown in Fig. 1. We can conclude that the proposed design has a low insertion loss around 2.1 GHz, shown as S_{31} in Fig. 2. A result of -0.17 dB at this frequency (lower than 0.5 dB, including the port connector loss) indicates that the loss is very low, and it transmits well. Similarly, it also provides high isolation for Port 2 and 4 over the same band.

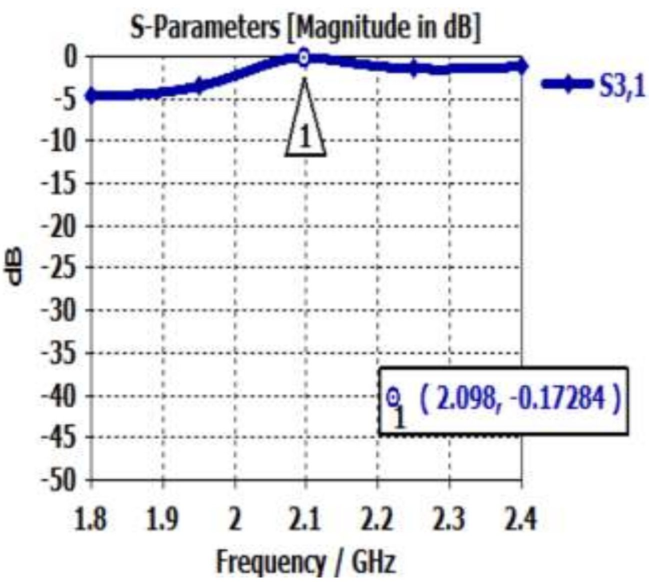

Fig. 2 S_{31} for proposed planar crossover

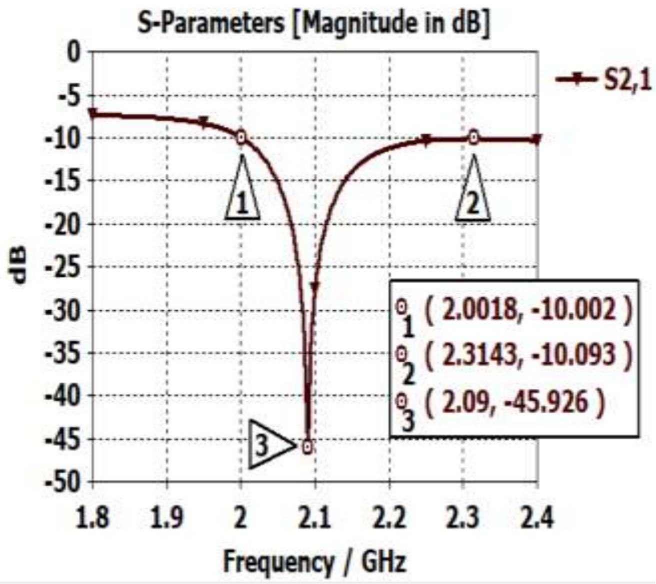

Fig. 4 S_{21} for proposed planar crossover

In Fig. 3, it appears that at the 2.1 GHz frequency, the power reflected to the input is almost absent at the -33.05 dB value. This return loss is below -10 dB and is close to ideal results for the proposed design.

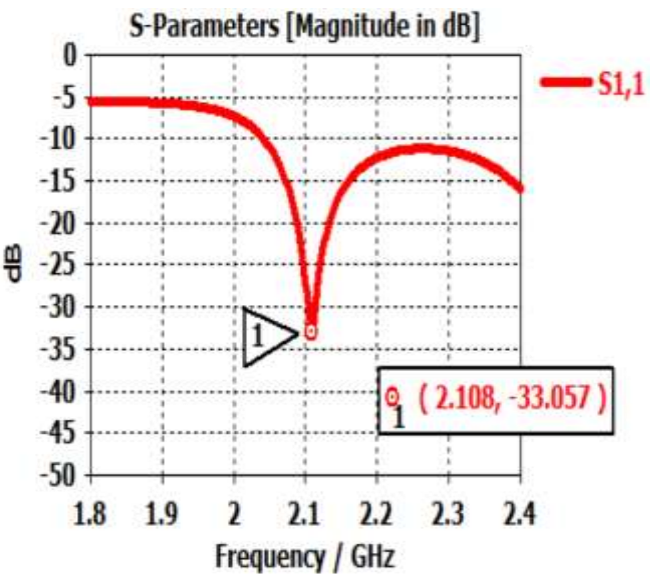

Fig. 3 S_{11} for proposed planar crossover

Fig. 4 shows the S_{21} parameter characteristics of the planar crossover and it is clear that with a remarkable bandwidth at 2.1 GHz, losses are less than -45 dB for future operation in this band for use in higher RF and microwave integrated circuits.

Another important point is that it also appears to operate over a wide bandwidth between 2.0 GHz and 2.3 GHz below -10 dB. Here it shows that the signal applied to the input port is well isolated from the Port 2.

IV. DISCUSSION

In this paper, a crossover is designed to reduce the complexity of complex RF circuits and MICs provide easy analysis and provide a planar solution in LTE applications. In the proposed study, it has a wide operating bandwidth and offers diversity in terms of size and design among different forms compared to previous studies. Ensuring isolation and lossless signal transfer coincide with the findings. Thus, the results presented improved methods for the applicability of the proposed design concept and diagonal structure.

V. CONCLUSION

The study has the main theoretical contributions to the literature. Primarily, this study is an innovative study that analyses the MICs and RF circuits complexity by finding a solution, taking into account that it has a planar structure that is easy to manufacture, reduces signal losses and provides a very good level of power transmission.

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