OPTIMAL MICROSTRIP BENDS

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Abstract In this work, we discuss two compensation techniques [1] for a 90° right angle microstrip bend. A broad frequency range is considered. The microstrip bends are optimized to achieve the possible minimum reflection at each port.

I. INTRODUCTION

In this report, we discuss two configurations to compensate the discontinuities of a microstrip bend. The microstrip bends concerned are symmetric and are connected to 50 Ω impedance at each port. A bend with a slit as shown in Fig. 1(a) is the first configuration. The second compensation technique is to miter the bend as illustrated in Fig. 1(b). The optimization variable for the bend in Fig. 1(a) is d_1 with d_2 equal to 1 mil, 3 mil, 4 mil. It is noted that d_1 and d_2 represent the length and the width of the slit, respectively. For the configuration in Fig. 1(b), the optimization variable is d.

II. DESIGN SPECIFICATIONS

The two configurations in Fig. 1 are optimized to achieve the possible minimum reflection at each port. Therefore the design specifications is given as

$$|S_{11}| = 0$$

in the frequency range from 18 to 30 GHz. The width w, the height h and the relative dielectric constant ε_r are fixed during optimization. Their values are

$$w = 15 \text{ mil} \qquad h = 15 \text{ mil} \qquad \varepsilon_r = 9.8$$

Three CAD packages are used for the simulation and optimization, Sonnet ***em*** [2] to compute the scattering parameters of the microstrip bends, OSA90/hope [3] to construct the circuit file and perform the optimization and Empipe [3] to parameterize the geometry of the bends.

III. OPTIMIZATION RESULTS

The microstrip bend in Fig. 1(a) is optimized to satisfy the design specifications. The length of the slit d_1 with the width of the slit d_2 equal to 1 mil and 2 mil is considered. We optimize the structure with respect to d_1 at each value of d_2. The optimal values of d_1 are given in Table I. $|S_{11}|$ at the optimal value of d_1 for d_2 equal to 1 mil and 2 mil is shown in Fig. 2. $|S_{11}|$ of the basic 90° right angle microstrip bend without any compensation is also shown in Fig. 2 for the purpose of comparison. It is noted that the optimal responses at d_2 equal to 1 mil and 2 mil are good and very close to each other.

The compensation technique in Fig. 1(b) is to miter the basic 90° right angle bend. The mitered bend is optimized with respect to d. The solution is unique and is given in Table II. The optimal response of $|S_{11}|$ is shown in Fig. 3 together with $|S_{11}|$ of the basic bend for comparison.

Fig. 4 shows $|S_{11}|$ in the frequency range 18 GHz to 30 GHz for the optimal structures of the configurations in Fig. 1 and the basic bend. It is noted that the optimal bends give good response.

CONCLUSION

In this report, we presented two compensation techniques for a 90° right angle microstrip bend. The two structures in Fig. 1 were proposed in literature [1] and they are optimized here. Optimization is carried out with respect to proper dimensions to reach a possible minimum reflection at each port. Sonnet ***em*** simulator as well as the robust optimizer in OSA90/hope have been used to perform direct optimization. The optimization results indicate that the two compensation techniques are effective to reduce the effect of the discontinuities in a microstrip bend.

REFERENCES

[1] E. H. Fooks, R. A. Zakarevicius, "*Microwave Engineering Using Microstrip Circuits*", Prentice Hall, 1990

[2] em^{TM} and $xgeom^{TM}$, Sonnet Software, Inc., 135 Old Cove Road, Suite 203, Liverpool, NY, 13090-3774, USA

[3] $OSA90/hope^{TM}$, $Empipe^{TM}$ and $Empipe3D^{TM}$, Optimization Systems Associates Inc., P.O. Box 8083, Dundas, Ontario, Canada L9H 5E7, 1994

TABLE I

MINIMAX OPTIMIZATION RESULTS OF THE BEND WITH A SLIT

CAD Software	d_2 (mil)	Optimal Value of d_1 (mil)
Sonnet ***em***, Empipe, OSA90/hope	$d_2 = 1$	8.11025
	$d_2 = 2$	6.17696

TABLE II

MINIMAX OPTIMIZATION RESULTS OF THE MITERED BEND

CAD Software	Optimal Solutions (mil)
Sonnet ***em***, Empipe, OSA90/hope	$d = 18.8257$

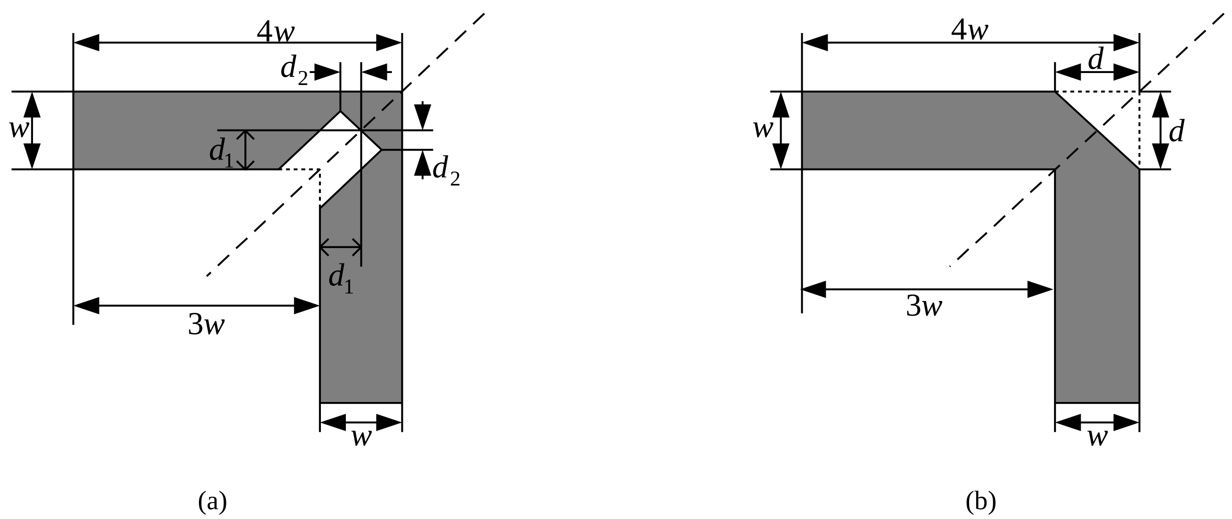

Fig. 1 The illustration of two compensation techniques

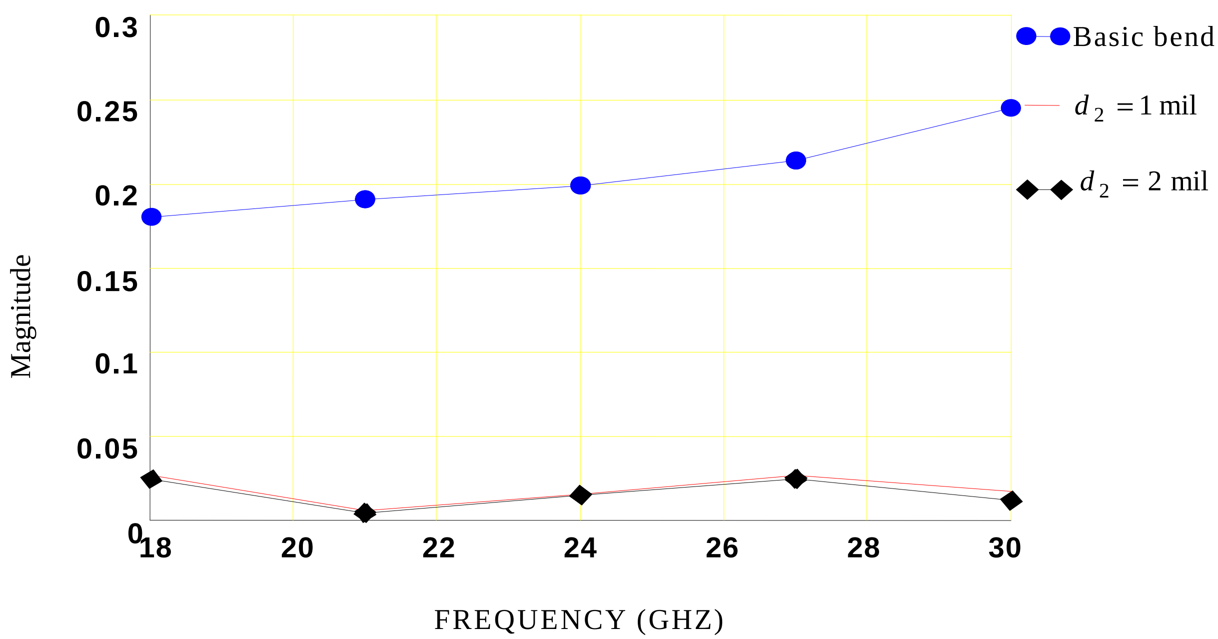

Fig. 2 $|S_{11}|$ for the basic 90° right angle microstrip bend and the optimal bend in Fig. 1(a) with d_2 equal to 1mil and 2 mil

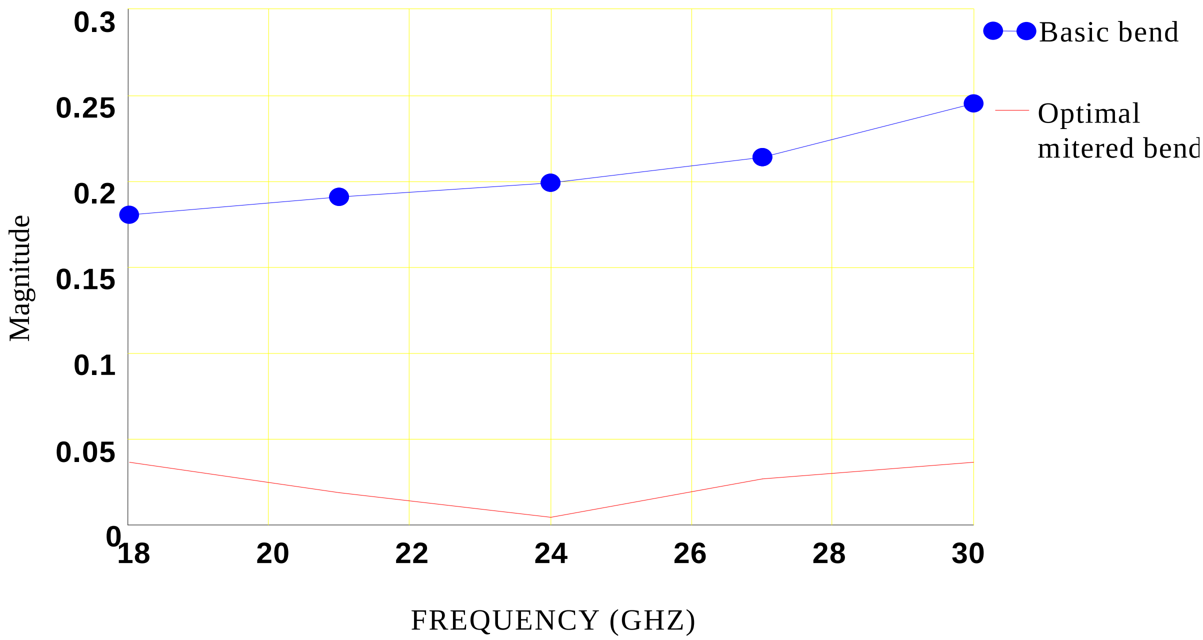

Fig. 3 $|S_{11}|$ for the basic 90° right angle microstrip bend and the optimal mitered bend in Fig. 1(b)

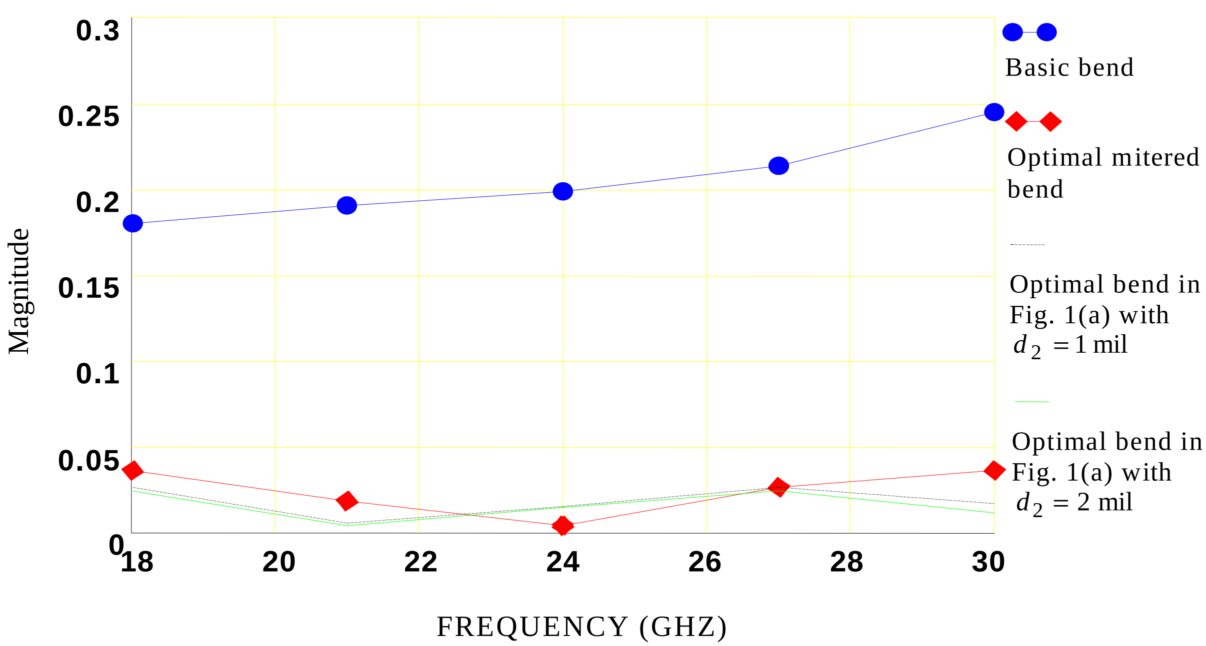

Fig. 4 $|S_{11}|$ for the basic 90° right angle microstrip bend and the optimal bends shown in Fig. 1 (a) and (b)