Effects of Di Electric Loading on Wave Guide H Plane Tee Junctions

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ABSTRACT

Slot radiator arrays are used to improve directivity. Slots can be vertical, inclined, or longitudinally oriented in the narrow walls of a rectangular waveguide because vertical slots could not radiate; instead, slightly inclined slots from the broadside are employed, producing horizontally polarised fields. Nevertheless, even little inclinations result in cross-polarized components, which cause EMI issues.

The literature does not take work on dielectric loaded slots into account for this study. So, it is worthwhile to research such slots in order to manage coupling, impedance loading, and VSWR. The information offered in this study is very helpful for both small and big array designs. The idea of self-reaction, discontinuity in modal current, coupling, and VSWR are all used in the study in this paper.

Keywords:- *Slot coupled waveguide junctions, Waveguide slots, Dielectric loading*

Introduction

The available literature [1–5] makes it clear that adding dielectric loading can change the waveguide junction radiators' overall admittance characteristics. It is interesting to provide in-depth research on how coupling, VSWR, and analogous network variables change when different types of dielectric slabs are present.

The current data can be used to design an array of these slots. In actuality, dielectric loading would be a further design factor for junction coupled slot arrays. The slots taken into consideration in this instance are quite beneficial for high power applications.

Only the slots that are completely in the thin wall and have a certain inclination are taken into consideration to make them appropriate for planar arrays.

The calculated information on how normalised conductance and susceptance change with frequency for increased slot inclinations with variable dielectric loading taking into account the feed and connected guides is provided. The outcomes are shown.

FORMULATION

The Tee junction of present interest is shown in Fig. 1. The geometry and co-ordinate system for the slot is also shown in the same figure. The electric field in the aperture plane of the slot is replaced by an equivalent magnetic current, Idm.

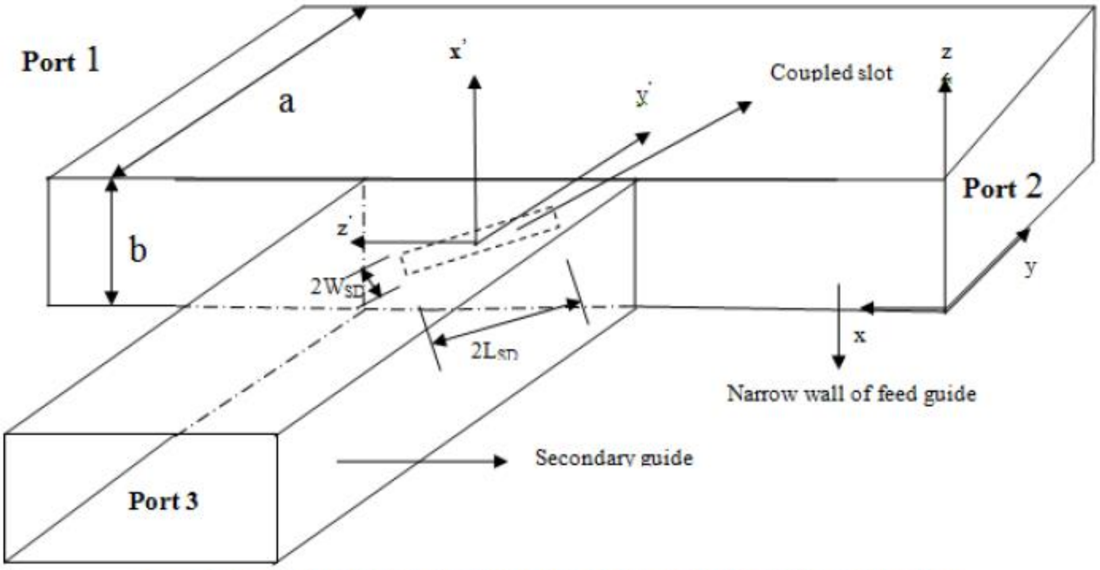

Fig 1. Inclined slot in the narrow wall of a rectangular waveguide Tee junction

The Expression for self-reaction is of the form

$$<s, s>_{fc} = -\iiint H_{SD} \cdot M_{SD} dv \qquad (1)$$

The electric field distribution $\overline{E}_{SD}$ in the aperture plane of the slot is related to the equivalent magnetic current $\overline{M}_{SD}$ by the relation.

$$\overline{M}_{SD} = \overline{E}_{SD} \times \overline{U}_n \qquad (2)$$

Since the magnetic current is distributed over the surface, the volume integral appearing in the expression of self-reaction (2) is reduced to a surface integral.

Taking the effect of image in the wall y=b into account, the expression for the self-reaction takes the form,

$$<s,s>_f = -\int_s \overline{H}_{SD} \cdot 2\overline{M}_{SD} ds \qquad (3)$$

The modified expression for self-reaction in guide 2 considering the effect of dielectric loading is obtained as

$$<s,s>_c = \sum_m^{\infty}\sum_n^{\infty} 2\gamma_{mn}\sqrt{K}(L^2)\left[\frac{SinF_2}{F_2}\right]^2 M^2 Sin^2\left(\frac{m\pi}{2}\right)\left[Cos(abF)^2\right](CosN)^2(X)$$

$$K=\frac{ab}{(ma)^2+(nb)^2}$$

$$L=\frac{E_m W_{SD}}{\pi}$$

$$F_2=\frac{n\pi W_{SD}}{a}$$

$$M=\frac{2K_{r2}}{K_{r2}-\left(\frac{m\pi}{b}\right)^2}$$

$$F=\frac{n\pi}{ab}$$

N= $K_{r2}L_{sd} - Cos\frac{m\pi}{b}L_{SD}$

X= $\left[\frac{\varepsilon_m \varepsilon_n}{j\omega\mu_0}\left(\frac{n\pi}{b}\right)^2 + \frac{4j\omega\varepsilon_0}{\gamma_{mn}^2}\left(\frac{n\pi}{a}\right)^2\right]$

$K_{r2} = \frac{2\pi}{\lambda}\sqrt{\varepsilon_{r2}}$, ε_{r2} is the dielectric constant in the coupled or secondary guide.

2.1 EXPRESSION FOR DISCONTINUITY IN MODAL CURRENT

The expression for the discontinuity in modal current I_{dm} given by [1] is modified taking the dielectric loaded slot in the narrow wall into account and is expressed as

$I_{dm} = E_{max}K_{r1}\left[\frac{A'}{B'}\right]\left[CosC' - CosD'\right]\left[\frac{SinW_{SD}X'}{W_{SD}Y'}\right]$

$A' = \frac{1}{\mu_0 fc}\sqrt{\frac{2}{ab}}$

$B' = K_r^2 - (\beta_{01}Sin\theta)^2$

$C' = \beta_{01r}L_{SD}Sin\theta$

$D' = K_{r1}L_{SD}$

$X' = \beta_{01r}Sin\theta$

$Y' = \beta_{01r}Sin\theta$

θ is the angle inclination of the slot and $\beta_{01r} = \left[K_{r1} - \left(\frac{\pi}{b}\right)^2\right]^{\frac{1}{2}}$

III. RESULTS AND CONCLUSIONS

Using the above expressions, computations are made to obtain the resonant length of dielectric loaded inclined slot in the narrow wall of a rectangular waveguide for each relative permittivity value and using the corresponding resonant length and the same expressions, normalized admittance are numerically computed. In the present case computation has been done with variation in dielectric loading in the feed(waveguide 1) From the computed results, variations of normalised conductance and susceptance as a function of frequency for a resonant slot lengths , dielectric constants of 2.3 slot widths of 0.1 cm for slot inclinations of 70^0 are presented in fig.2 to fig.3.

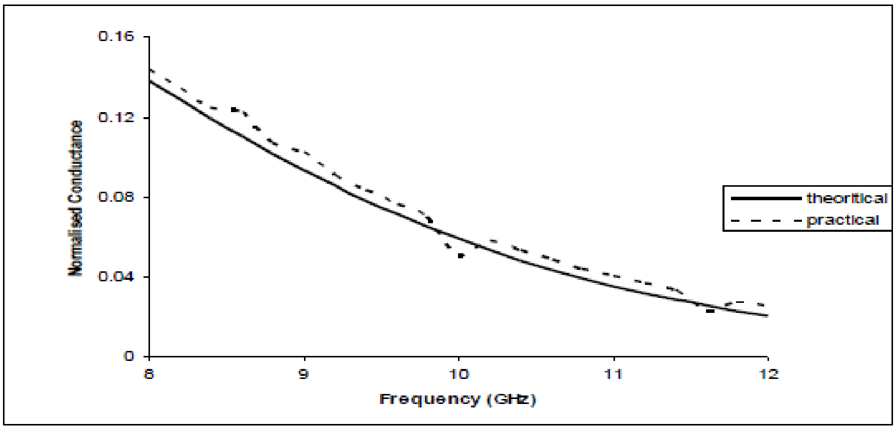

Fig 2. Conductance with frequency for slotwidth = 0.1 cm, slot inclination = 70^0

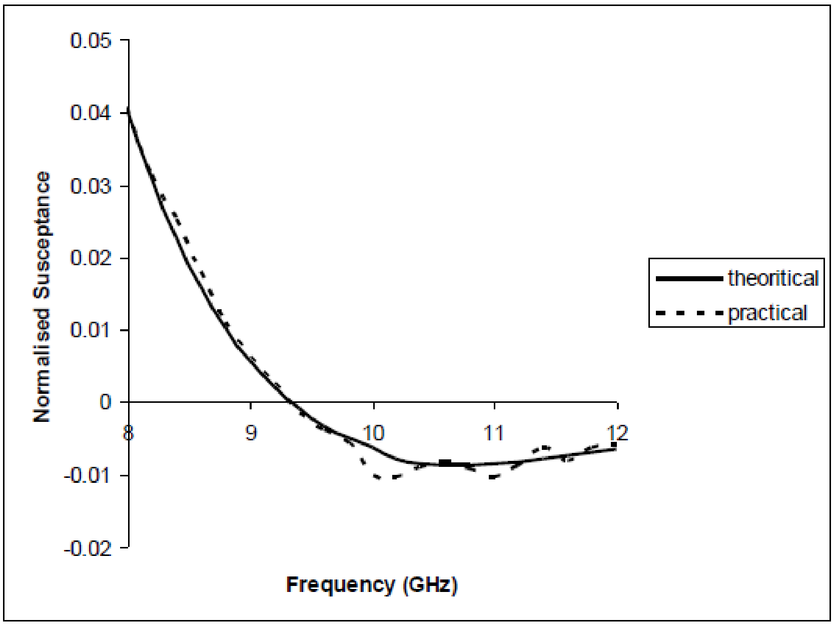

Fig 3 Susceptance with frequency for slotwidth = 0.1 cm, slot inclination = 70^0

From the investigation carried out in this work the experimental results are in agreement with the validity of the theoretical analysis. Teflon loaded guides exhibit higher admittance values whereas the waveguides loaded with higher dielectric constant, It is evident from the results that dielectric loading has considerable effect on the variation of admittance parameter and can be used as an additional parameter for the design of slot coupled H-plane Tee junction arrays.

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