ABSTRACT

Suspended slot line is a slot line suspended in the H-plane of a rectangular waveguide housing. This thesis presents a rigorous analysis of this line and its variants for cut-off frequency, propagation constant, bandwidth, power handling capability, characteristic impedance and losses. The structures analysed are: symmetric suspended slot line, suspended slot line with arbitrary located slot, single fin suspended slot line, single fin bilateral slot line and antipodal suspended slot lines. A slot line resonator was also analysed for the resonant frequency and end-effect. All the results pertain to the slot line in X-band waveguide housing.

Symmetric suspended slot line was first analysed using integral equation approach and fin current as unknown. The analysis was carried out in spectral domain using method of moments. The Green's functions were obtained using spectral domain immittance approach. Cut-off frequency and propagation constant for odd as well as even modes of the structure were determined. The structure was also found to support LSM-mode which is the fundamental mode of a partially filled rectangular waveguide. The numerical solution was found to exhibit relative convergence behaviour.

The fin current approach is observed to be inefficient since it requires more number of basis functions for an accurate solution. Therefore, the structure was later analysed using slot field as unknown in the integral equation approach. Separate basis functions were used for the odd and even modes. The basis functions used for the odd-mode are same as that used for the analysis of fin lines. For the even-mode, basis functions in power series expansion were used.

The cut-off frequency was obtained by substituting the propagation constant $\beta=0$ in the determinant of the coefficient matrix and finding its zero. The computer programme was standardised by computing the cut-off frequency and propagation constant of fin line. Then the results for suspended slot line were computed and compared with those available in the published literature. The agreement was excellent in all the cases. The cut-off characteristics and propagation constant for

a suspended slot line with arbitrary located slot is also presented. The measurement of propagation constant was carried out for an arbitrary located slot. The agreement between the measured and computed values is found to be fairly good. Excitation of suspended slot line by waveguide and suspended microstrip are also discussed.

Electric field distribution for the odd, even and LSM modes was computed and plotted. Even /odd electric field distributions were found to be similar to the even /odd field distributions for coupled microstrips. Field distribution for the even-mode for different slot widths show that the amount of power coupled from the lower half to the upper half of the slot line increases with increase in slot width. This will be useful for the design of directional couplers and power dividers.

Characteristic impedance based on power-voltage $Z_0(P,V)$ and voltage-current $Z_0(V,I)$ definitions was computed for the odd-mode. The ratio $Z_0(P,V)/Z_0(V,I)$ reaches $4/\pi$ as the width of the slot approaches the full width of the waveguide. The conductor and dielectric losses for the odd and the even modes were calculated. The variation of even-mode conductor loss is similar to that of a rectangular waveguide propagating the TE_{10}-mode. But the magnitude of the loss is more due to the presence of the fins. The maximum slot electric field of a single fin suspended slot line for unit power flow was computed and compared with that of fin line. It was found that the slot field in suspended slot line is lower compared to the fin line resulting in larger power handling capability.

Analysis of the variants of the suspended slot line showed that antipodal bilateral slot line can be designed to have a cut-off frequency of about 850MHz with an X-band waveguide housing. This will result in miniaturisation of circuits. The short-end effect is about 11.5% in slot line resonator compared to about 8% in fin line resonator.

Metallisation plane in suspended slot line is compatible with suspended strip and coplanar waveguides. Therefore, it should be easier to integrate suspended slot line with these lines and develop useful double-layer components.