

SPECTRAL-DOMAIN ANALYSIS OF
FIN-LINE RESONATORS

by

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CERTIFICATE

This is to certify that the dissertation entitled "Spectral-Domain Analysis of Fin-Line Resonators", which is being submitted by Mr. AKHILESH KUMAR AGRAWAL to the Indian Institute of Technology, Delhi, for the award of degree of Doctor of Philosophy, is a record of bonafide research work carried out by him under my guidance and supervision.

In my opinion, this dissertation has reached the standard fulfilling the requirements of the regulations relating to the degree. The results contained in it have not been submitted, in part or in full, to any other university or institute for the award of any degree or diploma.

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Abstract

This thesis presents an analytical study of single and coupled rectangular slot resonators in fin-line configuration. The analysis is based on Galerkin's method in Fourier transform domain. Experimental verification of the theoretical results on the resonant frequencies of single slot resonators in fin-line as well as in open configuration is provided.

The spectral-domain analysis of a single slot resonator in unilateral fin-line is carried out first and a characteristic equation is derived for determining its resonant frequency. The characteristic equation for resonators in bilateral fin-line is obtained by a suitable modification in the boundary conditions and structural parameters. By considering the walls of the shielding enclosure sufficiently far apart, so that they have negligible influence on the slot fields, the above characteristic equations are used to determine the resonant frequencies of single slot resonator and broad-side coupled resonators in open configuration. The characteristic equation for the determination of resonant frequency is modified to determine the wavelength in each configuration having an infinitely long slot. With this information the end-corrections in slot resonators in open/fin-line configurations are computed as a function of the structural parameters.

Characteristic equations to determine the even- and odd-mode resonant frequencies of coupled rectangular slot resonators in fin-line/open configurations are derived. These are obtained as a modification of the characteristic equation of the corresponding single resonator configuration by the application of shifting theorem. Three cases of coupling configurations have been considered in unilateral fin-line as well as in open slot configurations. They are (i) parallel-coupled resonators (ii) parallel-coupled offset resonators, and (iii) end-coupled resonators. Effects of structural parameters on the even- and odd-mode resonant frequencies and end-corrections for the above three types of coupled resonators in unilateral fin-line for both centered and off-centered fin locations have been studied. Numerical results on the resonant frequencies of coupled resonators in open configuration are also reported.

A class of resonators using double dielectric fin-line with an intervening airgap between the two dielectric substrates is studied. The air gap between the substrates serves as a variable parameter and provides flexibility in the design of resonant structures. Both single as well as edge-coupled resonators are considered. The two substrates carry identical resonator patterns which form mirror images of each other. The variations of resonant frequencies are studied as a function of the air gap for two cases; namely, (i) with fins on the two substrates facing each other and (ii) with fins facing the

adjacent side walls of the guide. In the second case, when the air gap is set equal to zero, the structure reduces to a bilateral fin-line. Resonant frequencies of edge-coupled resonators in bilateral configuration have also been computed.

In order to verify the accuracy of numerical results, experiments were carried out on some sample resonator configurations. The effect of side walls on the resonant frequency of single slot resonator has been studied experimentally. Resonant frequencies have been measured on single slot resonators in unilateral fin-line configuration for centered and off-centered fin locations at X- and Ka-bands and verified with theory. Similar experiments have been repeated on bilateral fin-line resonators and compared with the computed resonant frequencies. Fairly good agreement is found between theory and experiment in all these cases.

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