

STUDIES ON FINLINE DISCONTINUITIES AND THEIR APPLICATIONS IN PERIODIC STRUCTURES AND FILTERS

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DOCTOR OF PHILOSOPHY

by
ANIMESH BISWAS

**CENTRE FOR APPLIED RESEARCH IN ELECTRONICS
INDIAN INSTITUTE OF TECHNOLOGY
NEW DELHI, INDIA**

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DEDICATED

TO

MY MOTHER

CERTIFICATE

This is to certify that the work reported in this thesis entitle "Studies on finline discontinuities and their applications in periodic structures and filters" by Animesh Biswas has been carried out under my guidance and supervision. The results contained in it have not been submitted in part or in full to any other University or Institute for award of any degree or diploma.

Date : *Jan 5, 1988*

Bharathi Bhat

BHARATHI BHAT
Professor and Head
Centre for applied Research in Electronics
Indian Institute of Technology
New Delhi - 110 016, INDIA.

SUMMARY

This thesis presents a comprehensive study of a discontinuities in finline. Utilizing the discontinuity data generated both bandpass and bandstop filters have been designed and experimentally tested.

The discontinuities which are analysed in this thesis are, in either unilateral or asymmetric finline configuration. The dominant mode propagation constant and characteristic impedance of these finlines are determined first, as these parameters are essential for characterizing the discontinuities. A rigorous hybrid mode analysis is used for determining these basic propagation parameters.

For the characterization of discontinuities, a model of a finline cavity housing the discontinuity is considered. The fields in the various regions of the cavity are expressed in terms of modal fields with unknown coefficients. These unknown coefficients are expressed in terms of transformed fields across the slot aperture by satisfying the boundary conditions at the interfaces followed by applying the orthogonality condition at the aperture plane. Then Galerkin's procedure is used to obtain a set of homogeneous equations in terms of unknown coefficients of transformed aperture fields. By setting the determinant of the coefficient matrix equal to zero and solving, we can obtain the resonant length of the cavity for a specified

frequency. The impedance parameters of the equivalent circuit of the discontinuity are then calculated by applying the transverse resonance condition to the cavity.

While the method of analysis is rigorous, the accuracy of the discontinuity parameters depends to a large extent on the accuracy of the assumed basis functions for the slot field distributions. In the numerical computations for each of the discontinuities, appropriate basis functions which incorporate the fringing of fields at the discontinuity edges are chosen for the slot field distributions. Numerical computations are carried out to evaluate the equivalent circuit parameters of a number of discontinuities. The discontinuities characterized are: (i) symmetrical and asymmetrical inductive strips in unilateral finline (ii) E-plane septum in dielectric loaded waveguide (iii) symmetric capacitive strips in unilateral finline (iv) symmetric notch in unilateral finline (v) rectangular patch discontinuity in unilateral finline and (vi) transversely coupled stub in asymmetric finline. Out of the six discontinuities listed above, the rectangular patch and the transversely coupled stub are new discontinuities which are analysed for the first time. In the case of first four discontinuities, the results of the equivalent circuit parameters computed using a new set of simple basis functions are compared with the theoretical and experimental results reported in the literature. The computed parameters, especially the transmission coefficients of the various discontinuities are verified experimentally.

Following the study of discontinuities, two types of periodic structures are analysed. They are (i) periodically loaded inductive strips in unilateral and bilateral finlines and (ii) periodically loaded coupled stubs in asymmetric unilateral and asymmetric bilateral finlines. The concept of Floquet's theorem is used to expand the fields in the various regions of the periodic structure. Then, by satisfying the boundary conditions at each interface followed by the application of Galerkin's procedure, we get a set of homogeneous equations in terms of transformed fields at the aperture region. The dominant mode propagation constant is then computed by setting the determinant of the coefficient matrix in homogeneous equations equal to zero. The passband-stopband characteristic of the periodic structure due to the coupling between dominant and next higher order modes of the slot fields is then plotted. The computed passband - stopband characteristics of periodically loaded inductive strips in unilateral and bilateral finlines, and coupled stubs in asymmetric unilateral and asymmetric bilateral finlines are reported.

The design and realization of band-pass filters using inductive strip loading in unilateral finline, and E-plane septums in dielectric loaded waveguide are reported. While the design procedure is based on well established filter theory, the realization is based on the accurate characterization of inductive strips and E-plane septums. Theoretical prediction of filter performance is shown to match well with the experimental results.

Bandstop filter has been realised using coupled stubs in asymmetric finline. The length of each stub is chosen such that the stub along with the inductive strip between the stub and main line behaves like a series resonant circuit. The length of the stub is accommodated by extending the height of the finline housing. The theoretical response of the filter is compared with the measured performance.

CONTENTS

CHAPTER-I		Page
INTRODUCTION		
1.1	REVIEW OF FINLINE DISCONTINUITIES	1
1.2	TECHNIQUES FOR CHARACTERIZING FINLINE DISCONTINUITIES	5
1.2.1	Experimental Method	5
1.2.2	Equivalent Waveguide Model	5
1.2.3	Hybrid Mode Analysis	6
1.2.4	Transverse Resonance Method	7
1.2.5	Generalized Variational Technique	7
1.3	REVIEW OF FINLINE PERIODIC STRUCTURES	8
1.4	SCOPE AND ORGANIZATION OF THE THESIS	9
CHAPTER-II		
HYBRID MODE ANALYSIS OF UNILATERAL AND ASYMMETRIC FINLINES		
2.1	INTRODUCTION	13
2.2	ANALYSIS OF FINLINE	14
2.2.1	Basis Functions for Unilateral Finline	27
2.2.2	Basis Functions for Asymmetric Finline	30
2.3	EXPRESSION FOR CHARACTERISTIC IMPEDANCE	30
2.3.1	Unilateral Finline	31
2.3.2	Asymmetric Finline	33
2.4	NUMERICAL RESULTS	34

CHAPTER-III

CHARACTERIZATION OF SYMMETRIC AND ASYMMETRIC INDUCTIVE STRIPS IN FINLINE

3.1	INTRODUCTION	41
3.2	TRANSVERSE RESONANCE TECHNIQUE	43
3.3	GENERAL ANALYSIS OF A DISCONTINUITY IN A FINLINE CAVITY	46
3.4	SYMMETRICAL INDUCTIVE STRIP	60
3.4.1	Slot Field Distributions	62
3.4.2	Experimental Method	66
3.4.3	Comparison of Theory and Experiment	68
3.5	ASYMMETRICAL INDUCTIVE STRIP	79
3.5.1	Slot Field Distributions	83
3.5.2	Numerical Results	90
3.6	E-PLANE SEPTUM IN DIELECTRIC LOADED WAVEGUIDE	95
3.6.1	Slot Field Distributions	95
3.6.2	Numerical Results	97
3.7	CONCLUSION	101

CHAPTER-IV

CHARACTERIZATION OF STRIP NOTCH AND PATCH DISCONTINUITIES IN UNILATERAL FINLINE AND COUPLED STUB IN ASYMMETRIC FINLINE

4.1	INTRODUCTION	102
4.2	STRIP DISCONTINUITY IN UNILATERAL FINLINE	104
4.2.1	Slot Field Distributions	104
4.2.2	Numerical Results	112

4.3	NOTCH DISCONTINUITY IN UNILATERAL FINLINE	118
4.3.1	Slot Field Distributions	118
4.3.2	Numerical Results	126
4.4	PATCH DISCONTINUITY IN UNILATERAL FINLINE	132
4.4.1	Slot Field Distributions	132
4.4.2	Numerical Results	143
4.5	COUPLED STUB IN ASYMMETRIC FINLINE	148
4.5.1	Equivalent Circuit Parameters	150
4.5.2	Slot Field Distributions	151
4.5.3	Numerical Results	156
4.6	CONCLUSION	160

CHAPTER-V

ANALYSIS OF PERIODIC STRUCTURE IN UNILATERAL AND BILATERAL FINLINE

5.1	INTRODUCTION	162
5.2	ANALYSIS OF PERIODICALLY LOADED UNILATERAL FINLINE	163
5.2.1	Slot Field Distributions in Unilateral Finline with Periodically Loaded Inductive Strips	179
5.2.2	Slot Field Distribution in Asymmetric Unilateral Finline with Periodically Loaded Coupled Stubs	182
5.3	ANALYSIS OF PERIODICALLY LOADED BILATERAL FINLINE	186
5.4	NUMERICAL RESULTS	195
5.5	CONCLUSION	205

CHAPTER-VI

DESIGN AND REALIZATION OF BANDPASS AND BANDSTOP FILTERS

6.1	INTRODUCTION	206
6.2	TRANSITIONS FROM FINLINE TO RECTANGULAR WAVEGUIDE	207
6.3	DESIGN OF BANDPASS FILTER IN UNILATERAL FINLINE USING INDUCTIVE STRIP LOADING	215
6.4	DESIGN OF E-PLANE BANDPASS FILTER IN DIELECTRIC LOADED WAVE GUIDE	228
6.5	DESIGN OF BANDSTOP FILTER IN ASYMMETRIC FINLINE USING TRANSVERSELY COUPLED STUBS	236
6.6	CONCLUSION	246
	DISCUSSION AND CONCLUSIONS	248
	REFERENCES	252