Lowpass Filter Design For Eliminate The Harmonic Signals Using Photonic Bandgap Structure

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Abstract

The goal of this study is to realize the PBG lowpass filter using novel PBG structure modification both upper layer and ground layer. It has been designed three aperture slots of ground layer for PBG structure which the center slot shape of ground is two type, rectangular and dumbbell. This PBG LPF has the character of the broader stopband and smaller size than typical LPF. The measurement results have matched the simulated ones. It has the cutoff frequency of each 4.465GHz and 3.52GHz and at least -20dB of the signal suppression at the stopband

I. Introduction

PBG(Potonic Band Gap) structure as specific structure of specific frequency pass filter[1,2] is studying for miniaturizing of wireless circuit device, for low pass filter, band pass filter, impedance matching circuit considered wide band characteristics, reduction characteristics and etc. and radiation to antenna from power amplifier output part is removed harmonics by PBG structure.[6]

According to apply for plane circuit(micro strip line or CPW), PBG has been studying for low loss and structure miniaturizing and recently using the etching structure on ground surface is studying[4,5]. Established researches are applied for analysis LC parallel equivalent circuit of the etching structure and recently researches are analyzed more closed equivalent circuit by considered radiation resistance of radiation loss[1,6].

In this paper we observe established research of PBG structure, and after optimizing by equivalent circuit for new PBG structure design the low pass filter for PBG structure. The optimum low pass filter can be designed by field simulation experiment

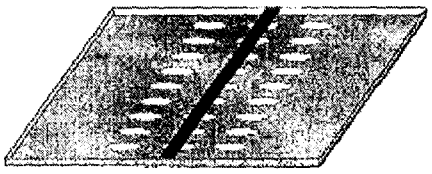
II. PBG structure

2-1 Structure of PBG filter

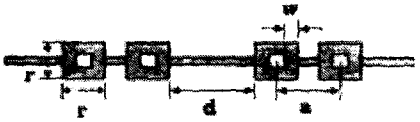
PBG structure constituted multi layer(single, double or triple layer) for efficient stoping wave of electric-magnetic wave in specific frequency band is fabricated by periodic punching of multi layer or array of suitable 2 or 3 dimensional conductor or dielectric material.

An advantage of this structure is to using in microwave/millimeter wave circuit or antenna by characteristics of wide band stopband. The PBG structure can be applied in gain approvement of antenna, miniaturizing of antenna size, ground surface, cavities and structure of waveguide in the future[4].

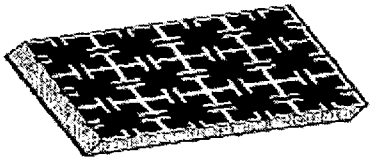
PBG structure is showed by generally four types in Fig. 1.



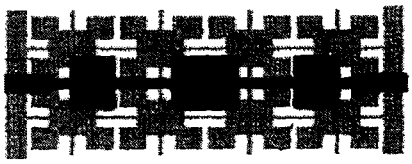
(a) method of 1 or 2 dimensional periodic arranging of opening surface on ground surface



(b) method of periodic arranging of specific form of conductor on transmission line



(c) method of arranging of periodic structure by etching conductor on ground surface



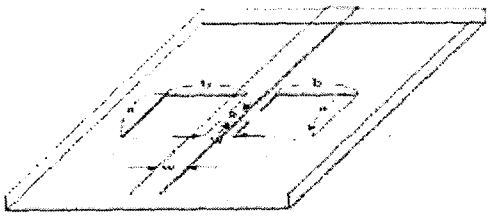
(d) method of suitable modification on transmission line and ground surface

Fig. 1. General form of PBG structure

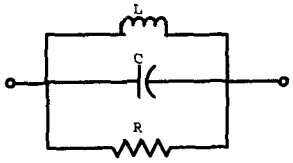
2-2 Equivalent circuit of PBG structure

As the most simple structure of PBG Fig. 2(a) is designed etching by opening surface on ground surface and Z0 micro strip line is extant in upper layer. Fig. 2(b) is equivalent circuit of serial connected parallel RLC circuit considered inductance L[1] through the etching opening surface on ground surface and radiation resistance R.

To get the parameter of equivalent circuit serial L of low pass filter prototype is transformed parallel LC of bandstop filter through the impedance and frequency scaling. In this processing the equal of two circuit and LC value using 3dB stop frequency of in EM simulation is decided, and radiation resistance(R) is decided by decided LC value and suitable sampled (ω)(generally ω=ωo) in EM simulation.



(a) Simple PBG structure using etched ground surface



b) Equivalent circuit

Fig. 2 Simple PBG structure and equivalent circuit

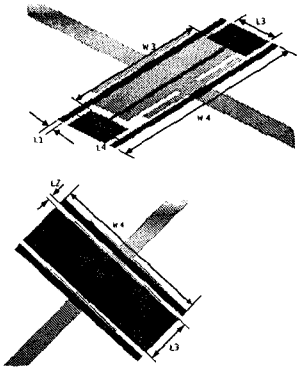
III. Design of low pass filter

3-1 Low pass filter Structure

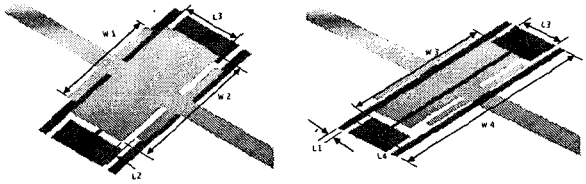
The low pass filter mainly materialized by parallel stove or step impedance line, but the filter using stove line consumed more space for circuit design, have narrow band and spurious pass band in stopband.

Cause of this fault new method for fabricating filter using PBG principle was formed a prescribed stopband is proposing. But the filter using PBG structure has a fault of consumed more space as periodic structure for effective formation of stopband.

For covering this fault we propose the PBG structure transforming transmission line and ground surface in this experiment(Fig.3) Characteristics of stopband; the advantage of PBG structure, is approved and for easy controlling the stop frequency the structure were composed two lattice types; rectangular and dumbbell slot.



(a) Upper surface(L) and opening surface of ground(R)(rectangular slot)



(b) Upper surface(L) and opening surface of ground(R)(dumbbell slot)

Fig. 3 Two type of proposed PBG structure lattice

This structure is overlap the etched part of line of transmission line and ground surface, and for controlling the inductance and capacitance in etching part of micro strip line of important element to decide stop characteristics of specific frequency band and ground surface, to decide the suitable rate value of stove line in lattice and etching part is important.

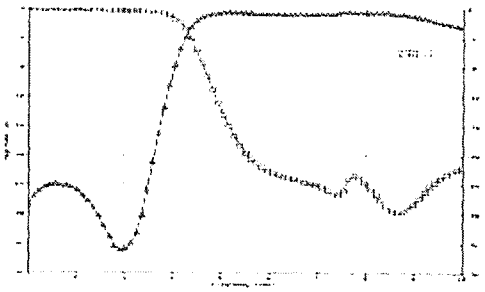
The value in lattice of proposed PBG structure is shown in table 1. Em simulation

As bigger the etching part of ground surface under control the stove line of transmission line and more narrow the gap, characteristics of stopband is more wide.

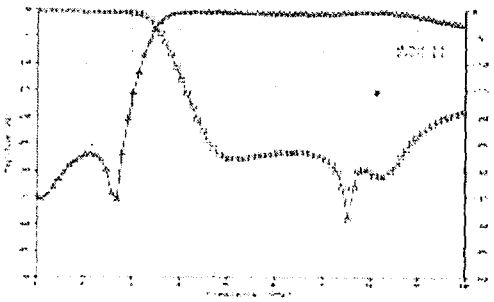
Table 1. Each value in lattice(mm)

	W1	W2	W3	W4	L1	L2	L3	L4
Value	12.211	14.771	2.211	20	1	1.5	6	0.5

3-2 Simulation



(a) Rectangular slot LPF result



(b) Dumbbell slot LPF result

Fig. 4. Simulation results of proposed low pass filter

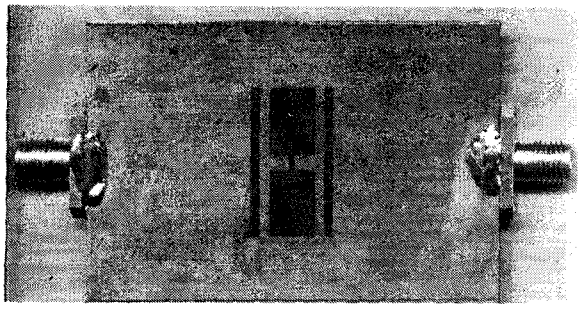
In this paper low pass filter of PBG structure was simulated by Ensemble before fabrication. Teflon() 31mip; In this paper low pass filter of PBG structure was simulated by Ensemble before fabrication. Teflon(<IMG src=".\PICA9.g

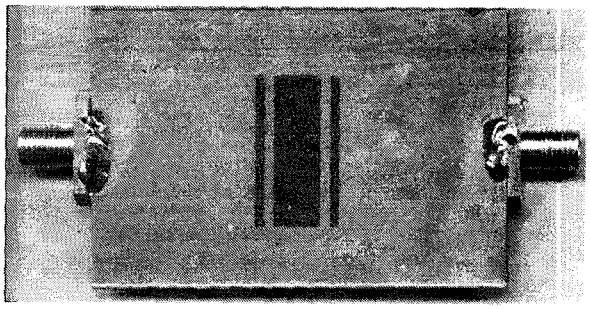
Fig. 4 is simulation results of low pass filter for rectangular and dumbbell slot lattice structure. The stop frequency is formed at 4.465GHz and observed characteristics of reduction over 27dB. And wide stopband was formed over 6GHz removed low pass filter □ □ □ □ □ mode of two lattice type. In dumbbell slot type case stop frequency can be tuning by insert slot.

IV. Fabrication and results

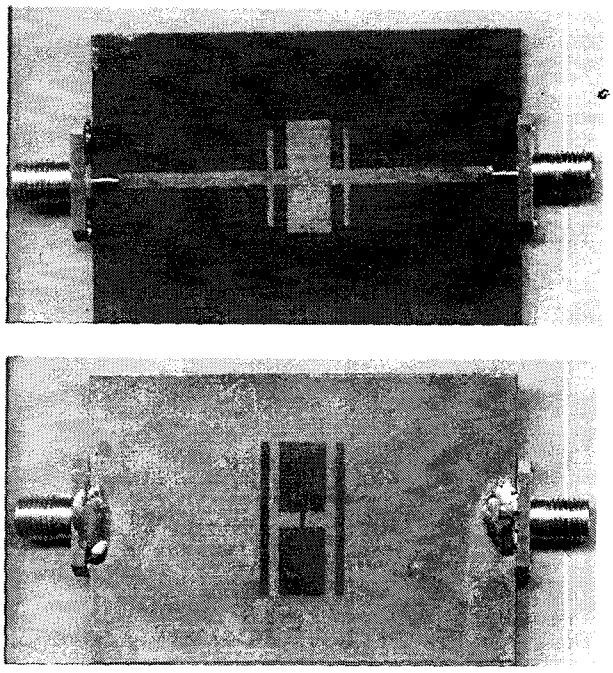
The low pass filter using the proposed PBG in this paper was fabricated and measured.

Fig. 5 is fabricated model using inductor substrate of Teflon 31mils.





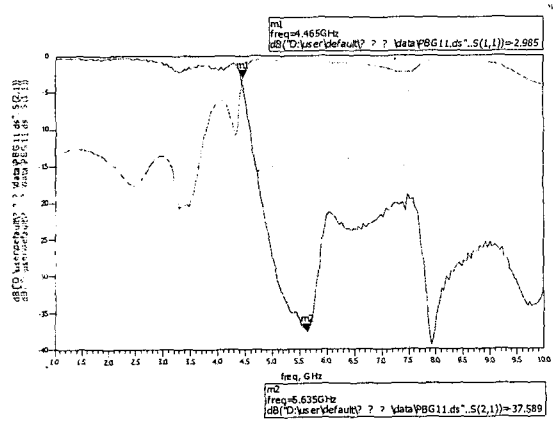
(a) Rectangular slot lattice structure



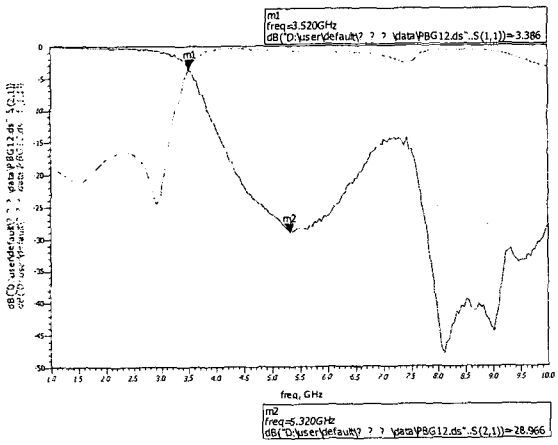
(b) Dumbbell slot lattice structure

Fig. 5. Fabricated low pass filter

Fig. 6(a) is the measurement result of rectangular slot lattice structure. The stop frequency is 4.465GHz, characteristics of stopband is wide stopband over 25dB. Fig. 6(b) is the measurement result of dumbbell slot lattice structure. The stop frequency is 3.52GHz, characteristics of stopband is wide stopband over 25dB. Low pass filter of dumbbell slot lattice structure is observed lower stop frequency than rectangular slot lattice structure's. The stop frequency were almost coincided the data of simulation but characteristics of stopband had some different gap. This was error of fabrication or measurement.



(a) Low pass filter result of rectangular slot structure



(b) Low pass filter result of dumbbell slot structure

Fig. 6. Result of low pass filter

V. Conclusion

In this paper using the transformation method of transmission line and ground surface new type PBG structure was under consideration and low pass filter was designed and fabricated. The low pass filter using the proposed PBG structure was measured by rectangular and dumbbell slot structure. As a result stop frequency were respectively 4.465GHz, 3.52GHz and characteristics of reduction were respectively over -24dB, over -27dB. This is wide low frequency band. The stop frequency were almost coincided the data of simulation but characteristics of stopband had some different gap. This was error of fabrication or measurement. The very small size(1.1cm×2cm) of proposed PBG structure can be used for miniaturizing of application circuit.

Reference

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