Analyzing Electromagnetic Band Gap Structures in Microstrip Leads: A Practical ComparisonDr. Ava Johnson*[1] & Noah Wilson

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KEYWORDS: SEBG, EBG, Micro Strip, and Mushroom.

ABSTRACT
In this paper, two new amazing sorts of stacked Electromagnetic Band Gap (SEBG) structures are proposed, its properties are overseen by utilizing Finite part technique (FEM) based test system and acquired outcomes are separated and traditional mushroom make electromagnetic band opening (EBG) structure. The proposed unit cell of SEBG structures incorporate two layers over the organizing ground plane; a lower layer, contains gathering of mushroom make EBGs with square fixes and an upper layer contains mushroom create planar structure. These structures are utilized as ground plane for low profile micro strip settle receiving leads. So as to finish the examination, return difficulty and radiation instance of a rectangular micro strip settle radio lead put over the proposed SEBGs and furthermore reference EBG surface are destitute down and separated.

INTRODUCTION
The huge progression in radio wire building empowers plan of diminished receiving wire [2] structures with improved execution characteristics. Different frameworks [3-5] have been proposed for downsizing of exuding radio wires, for instance, usage of high permittivity substrates or winding ways and fractal shapes receiving wires. Regardless, they are persisting with limit gathering mechanical assembly band - width and ohmic setbacks (fractal shapes radio wires). The unique properties of EBGs, demonstrating answer for issues, in this manner gathering mechanical assemblies are stacked by EBG surfaces [5-9], are the infrequent bunch of electromagnetic structures engraved on metal maintained dielectric substrate. The periodicity of a display is close to nothing and what's more the estimations of the individual particles in the unit cell (UC). Shape and estimations of the individual fix segments expect key part to structure of EBGs and association of its repeat response. Generally settle segments show in squared [10], hexagonal [11] and rectangular [12] shapes. The EBG surfaces may exhibit the two intriguing practices: one is phony alluring conductor (AMC), in which reflection arrange is close or identical zero. Another is restricted repeat band gap (FBG), in which no surface wave can spread along the surface. The AMC lead occurs because of high impedance in a specific repeat stretch out, in the midst of which the superfluous electric field sections is small, provoking a couple of fascinating applications in the gathering mechanical assembly field [10-15]. Likewise, dependent upon the geometry of the UC, the two practices may appear in a comparable repeat broaden [16, 17]. The AMC property helps in arranging of low profile receiving wires, as the image streams appear in stage, in this way gathering contraptions can be set parallel and close to the EBG grounds [18]. The FBG property can be useful in upgrading receiving wire radiation plans [10, 11]. Remembering the ultimate objective to decrease the hole of printed radio wires and upgrading the displays with respect to profitability and get, it is possible to use the possibility of EBG [10].Various preliminary methods for depicting the EBG lead can be pondered [19,20].

Stacked EBG surface has been displayed in [10], where the maker used three layer structures for gauge decreasing of unit cell. Camouflage of clatter in parallel plate waveguide was done by using stacked EBG structures in [21]. The examination of band opening properties in twofold layered dipole and triple groups is done in [22].

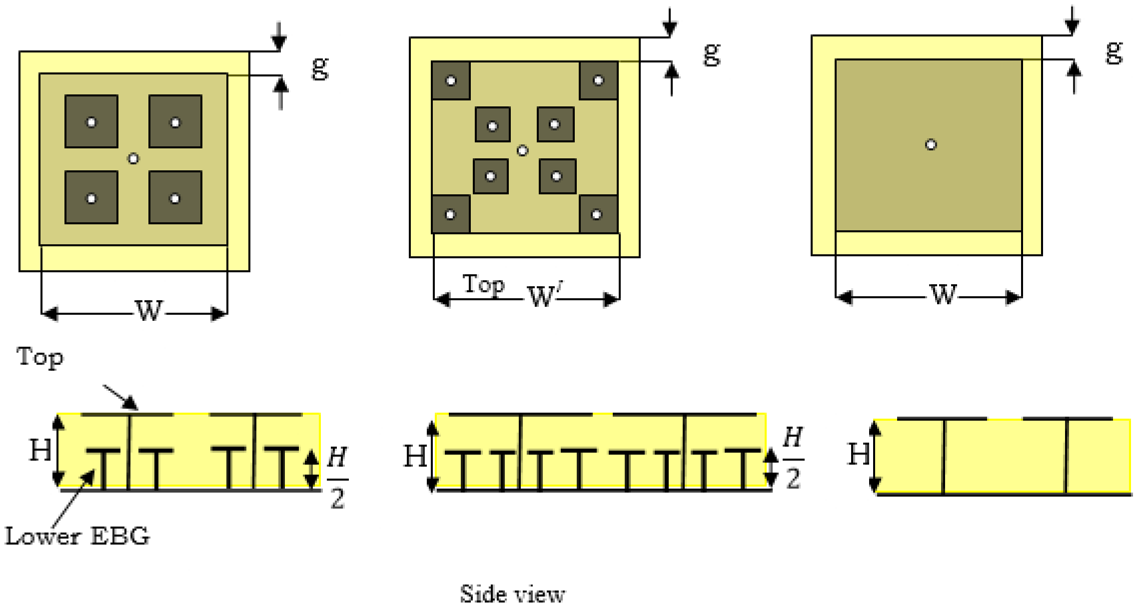
The fundamental structure of EBG involves intermittent display of dielectric or metallic fixes in one, a couple of estimations, engraved on one side of dielectric where inverse side contains metallic ground. The spread of electromagnetic waves prevent at explicit edges of event at a couple of frequencies. Such frequencies are called midway band gap, if the inducing isn't allowed in all of the direction and this repeat area is called comprehensive band gap [23, 24]. A kind of mushroom form surfaces have been picked as a base of arranging new SEBG and dynamic SEBG surfaces (three layer EBGs) because it has been considered extensively in composing. The proposed SEBGs are made by putting a planar mushroom compose EBG structure over a little show of mushroom form structures. The FBG and (AMC) in-arrange wave reflection properties of SEBG heaps of UC. The FBG is influenced with the parameters of both the lower and upper mushroom compose layers, whereas the in-arrange reflection property depends basically on the parameters of the upper planar mushroom layer, especially the range of the metallic fix and they may be tuned freely [25].

UNIT CELL SUGGESTS

Figure 1 shows the schematic diagram of mushroom structure (reference model) and two new SEBG structures, which were made on FR4 substrate, relative permittivity of 4.4, vulnerability of 1 and setback diversion of 0.02 with a thickness (stature) 'H' of 3.2mm (124mil). The cross area in Figure 1(a) involves square metal fix of 17.5X17.5 mm2 related with the interminable ground plane lying inverse side of substrate by a vertical driving stub (by methods for) of range 0.475mm, from their inside, while the matrix in figure 1(b) includes square metal patches sorted out in layers (stacked), where cut down layer contains display of four square metal patches having an estimation of 3.4X3.4mm2 mounted at a height H/2 of 1.6mm (62mil), set at four corners of UC, top layer contains planar square metal fix of size 17.5X17.5 mm2, set at a stature of 3.2mm. Every one of these patches is related with ground plane lying on the contrary side of substrate by a vertical driving stub of scope of 0.475mm from their center. The cross area in figure 1(c) includes vertically stacked game-plan of patches, where cut down layer contains dynamic show of square metal fixes, the assortment of square fixes set at four corners of a UC having estimations of 3.4X3.4mm2. Next show of square fixes set corner to corner with a size of 3.075X3.075mm2. Every one of these patches are put at a height H/2 of 1.6mm (62mil), related with ground plane lying on the contrary side of substrate by a coordinating vertical stub of range 0.475mm from their inside. Top layer resembles what is cleared up in 1(b). In this examination, to restrain EBG cell measure, the examiner has picked FR4 with thickness 3.2mm as the AMC metallization will get empowered by the energize line like a radio wire if EBG UC gauge is proportionate or more important than the transmitting patches. The summery of complete estimations of all of the two (one is reference show and other two proposed models) models are recorded in table I.

Parameter Name	**Symbol**	**Stacked EBG**	**Progressive stacked EBG**	**Mushroom type EBG (Reference Model)**
Metallic square patch	W X W	Top layer 17.5X17.5 mm^2 Lower layer 3.4X3.4 mm^2	Top layer 17.5X17.5 mm^2 Lower layer 3.4X3.4 mm^2 (first array) Lower layer 3.075X3.075 mm^2 (second array)	17.5X17.5 mm^2
Gap between patches	g	1mm	1mm	1mm
Stub radius	r	0.475mm	0.475mm	0.475mm
Dielectric substrate height	H	3.2mm	3.2mm	3.2mm
Dielectric permittivity and loss tangent		4.4, 0.02 (FR4)	4.4, 0.02 (FR4)	4.4, 0.02 (FR4)

Table 1: Dimensions of all two EBG UC models



(a) Stacked EBG, (b) Progressive stacked EBG (c) Mushroom type EBG (reference model),
Figure 1: schematics of EBG structures

ANALYSIS OF EBG STRUCTURES

Various strategies are accessible in writing for the investigation of EBG UC. They are comprehensively characterized into four classes [26]: 1) Lumped component circuit show, 2) Transmission line demonstrate, 3) Computational electromagnetic displaying and 4) Use of full wave solver. Because of the unpredictability of the EBG structures, it is typically hard to describe them with above indicated three diagnostic techniques. Full wave electromagnetic test systems that depend on cutting edge numerical techniques are prevalently utilized as a part of EBG examination. In this paper scattering graph and reflection stage highlights of EBG and SEBG are dictated by utilizing FEM based test system.

AMC BEHAVIOR ANALYSIS:

AMC is one of the unordinary however vital properties of the EBG structures. To decide the AMC property of three EBGs, FEM reenactment in light of the Bloch-Flout hypothesis (High Frequency Structure test system (HFSS) from An soft) is considered. In the FEM reenactments, two flawless attractive transmitters (PMC) and two impeccable electric conveyors (PEC) are connected on four sides of the UC intermittently. To demonstrate the impact of occasional replication in a boundless exhibit structure, and to acquire the reflection stage coefficient the wave port on the cell is de-installed, the total reproduction appeared in Figure 2

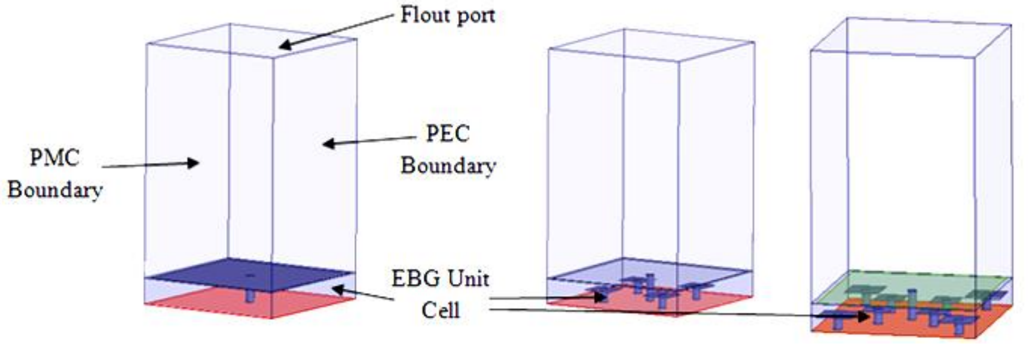


Figure 2: Simulation setup for measurement of coefficient of reflection for three EBG models

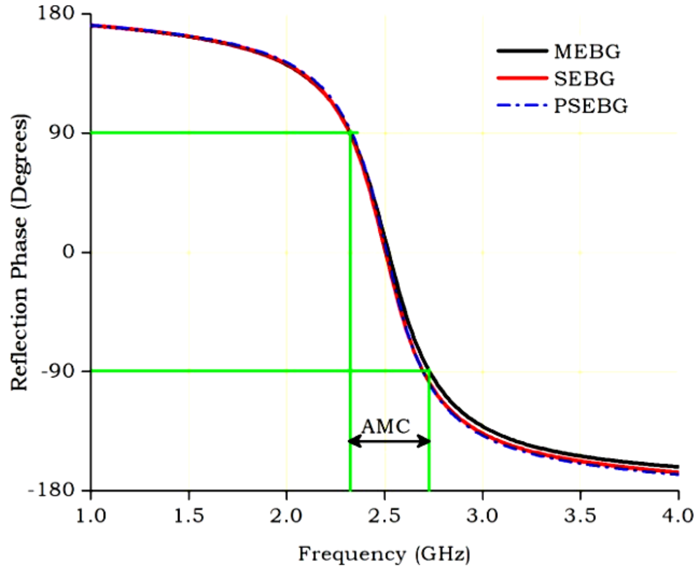


Figure 3: Reflection phase diagram

Figure 3 exhibits the coefficient of reflection organizes for the run of the mill event plane waves for EBG, SEBG and dynamic SEBG structures. It is moved steadily from +1800 to - 1800 in regard to the repeat. The repeat where the reflection organize is zero is the loud repeat of structure (now the surface impedance of specific structure is high). The reflected waves intrude with the scene waves in-arrange in the midst of +900 to - 900region, so the EBGs continue like an AMC in this area. The repeat of activity, AMC band width of EBG, SEBG and dynamic SEBG structures are removed from reflection arrange plot showed up in figure 3, and are portrayed in Table II. The SEBG structure is showing 1.22%, dynamic SEBG is indicating 1.59%, less AMC band opening appeared differently in relation to mushroom create EBG (reference) illustrate.

Table II

Parameter	**Stacked EBG**	**Progressive EBG**	**Mushroom EBG (Reference Model)**
Resonant Frequency	2.5GHz	2.5GHz	2.5GHz
In-phase band gap	373.8MHz	364.4MHz	404.2MHz
Fractional band gap (%)	14.95	14.58	16.17

FBG BEHAVIOR ANALYSIS

Under normal event, the EBG designs can't be isolated totally by their surface properties, so the FBG of EBG UC is obtained from its dissipating graph. The proliferation setup for estimation of FBG of EBG structures contain a flawless composed layer (PML) limit described on the most astounding purpose of the model to imply free space over the surface. Two faultless alluring transports (PMC) and two immaculate electric channels (PEC) are associated on four sides of the UC irregularly [43,44]. The whole estimation setup for every one of the three EBG models is exhibited figure5. In this paper -X course of spread [27] is considered. The dissipating plot (wave number stanzas repeat) contains first dispersing mode (most extraordinary estimation of mode 1 chooses the lower repeat purpose of constrainment of band opening) and second dispersing (mode 2). The intersection purpose of mode 2 with the light line chooses the farthest reaches of repeat band opening. By taking a gander at the zone between the lower and greatest purposes of restriction of band opening, a surface wave disguise band gap or illicit band gap is gotten. Table III outlines the FBG of mushroom EBG, SEBG and dynamic SEBG, where fragmentary FBG is diminishing from mushroom EBG to dynamic SEBG.

Table III

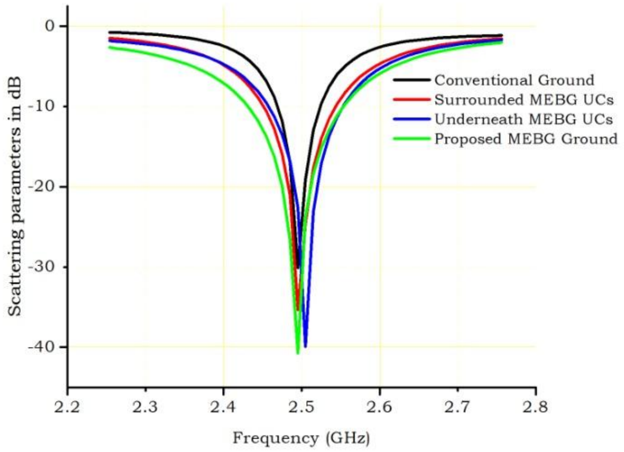
Parameter	Stacked EBG	Progressive EBG	Mushroom EBG (Reference Model)
Mode 1	1.43GHz	1.35GHz	1.55 GHz
Mode 2	3.56GHz	3.3GHz	4GHz
FBG	2.13GHz	1.95GHz	2.45GHz
Fractional FBG	85.2%	78%	98%

Table IV exhibits the reference models of a comparable kind (maintained EBG) and the gained results for better relationship of laid out model.

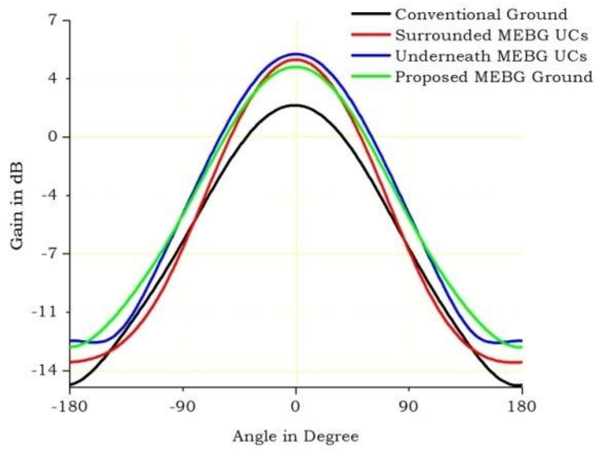
Parameter	Without EBG	With backed EBG	With backed EBG (modified)	With stackedEBG (Fig 1b)	With progressive stacked EBG (Fig 1c)	With Surrounded EBG
Patch size	32.55X26.85 mm^2	27.7X22.5 mm^2	27.3X22.1 mm^2	24.3X19.1 mm^2	22.35X17.15 mm^2	32.4X27.2m m^2
Ground size	56X106 mm^2	55.5X93.3 mm^2	55.5X92.3 mm^2	55.5X92.3 mm^2	55.5X92.3 mm^2	73X94.3 mm^2
Length miniaturization (%)	Reference	15	17	26	32	1
Width miniaturization	Reference	17	18	29	37	+1 (increased)
Resonating frequency	2.5GHz	2.5GHz	2.5GHz	2.5GHz	2.5GHz	2.5GHz
Return loss (dB)	-28.6	-36.24	-31.58	-36.64	-46.79	-37.6
Bandwidth (S11<-10dB)	80MHz	101.2MHz	130MHz	143.1MHz	167.5MHz	97.7MHz
% bandwidth	3.2	4.1	5.22	5.7	6.8	3.9
Peak Gain (dB)	5.03	6.03	5.94	5.93	5.81	5.59
Peak directivity (dB)	2.89	3.65	4	4.1	4.1	3.44
Radiation efficiency (%)	57.62	60.62	68.25	69.35	70.65	61.62
E plane beam width (Degree)	46.15	44.87	49.14	48.72	47.86	52.99
H plane beam width (Degree)	56.84	61.96	57.26	56.41	53.84	54.7
VSWR	1	1.0283	1.0525	1.0299	1.009	1.0263
FBR	219.64	15.92	21.32	24.68	20.819	150.63

SIMULATION RESULTS AND DISCUSSION

The reproduced spreading parameters of normal micro strip settle recieving wire (red shading), EBG UCs enveloped radio wire (green shading), 3X3 bunch of EBG UCs ground lying under the fix gathering mechanical assembly (blue shading) and changed EBG position under the fix radio wire (yellow shading) are showed up in figure 10(a), exhibits admire impedance organizing between partner point to the receiving wire and all of the receiving wires are resonating at 2.5GHz. The factional exchange speed of fix radio wire over a position modified EBG ground is more, when diverged from remaining all (above discussed) models. Directional E case of more than four models are showed up in figure 10(b), customary smaller scale strip settle accepting wire (red shading) has back radiation - 12dB, front radiation 4.6dB, EBG enveloped radio wire (blue shading) has back radiation of - 13dB, front radiation of 5.37dB, EBG ground lying under and covering the aggregate impression of the fix gathering device (green shading) has back radiation of - 12dB, front radiation of 5.6dB, changed EBG (proposed show, figure 9) UCs position under the fix getting wire (yellow shading) has back radiation of - 11.5dB, front radiation of 6.1dB. After relationship, it very well may be contemplated that changed position EBG structure transmitting an extensive part of the its essentialness forward way, less wastage in turn around course.



(a) Return Loss



(b) 2D-Gain

Table VIII:

Structure	**Front radiation**	**Back radiation**
Mushroom type EBG (Reference model)	6.1dB	-11.5dB
Stacked EBG	6.14dB	-9.5dB
Progressive stacked EBG	6.13dB	-8.5dB

From table V and figure 11, it can be concluded that new models of stacked EBG structures proposed in this paper are well suitable in designing of low profile radiating antenna, also achieve miniaturization in ground plane dimensions and improve the radiation performance in front radiation.

CONCLUSION

In this paper the phenomenal (FBG and AMC) properties of EBG urge to overhaul the radiation characteristics of gathering mechanical assembly with low profile. The mush room creates EBG structure is considered as reference. Two novel structures of EBGs are proposed named as SEBG and dynamic SEBG. The FBG and AMC properties of proposed models are resolved using FEM test framework, got comes to fruition are differentiated and reference EBG illustrates. The objective is to decide the situation of wellbeing gathering mechanical assembly on little ground with minimum back radiation, so mushroom EBG is used as ground for fix radio wire with different positions. In the wake of accomplishing the best position of EBG UCs ground, same kind of ground indicate is created using new SEBG and dynamic SEBG UCs, embedded in fix radio wire. They got happens showing that the radiation case of fix gathering mechanical assembly over proposed new SEBG is increasingly connected forward route with minimization in profile of exuding patch and ground plane.

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