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A Novel Design of Metamaterial Absorber for Polarization Insensitive Incident Angle in the Execution of Dual-Band

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***Abstract*—In this paper, We present a design and simulate of a dual-band and polarization insensitive for metamaterial (MTM) absorber in microwave frequency. The structure with thickness 0.05 mm comprises an outer Square ring, and Two split Circular rings incorporated with four square rings which will absorb to all incident electric and magnetic fields within a single copper sheet isolated by FR4 (4.4) substrates. The metamaterial absorber has been observing two absorption peak; one at 3.5GHz and 5.5GHz frequency mimicked with an absorbance of 99% respectively. Wi-Max is one of them that give high speed communication with full scope. Both frequencies work on Wi-Max application. The wide incident angle point starting range from 0^0 to 50^0 for both transverse electric (TE) wave and transverse magnetic (TM) wave. This MTM structure used for Wi-max application. After that, in this paper introduced its proposed design and simulation result that is executed in the CST Microwave studio software (frequency domain solver).**

Keywords*— Square & Circular rings, Band Metamaterial absorber (MTM), Wi-Max 3.5 and 5.5GHz band.

I. INTRODUCTION

The metamaterial absorber has been used to design for many years. Artificially composed metamaterial (MTMs) for the microwave terahertz, infrared, and optical region application [1] [2].In metamaterial, the electromagnetic (EM) parameters of permittivity and permeability, characterized by electric medium theory (EMT) have been exceptionally fitted through the design of unit cells of the metamaterial [3]. Ordinary microwave absorber is either viewed of lossy materials, metal or ferrite powders that can ingest EM waves over a specific frequency extend, or using at least one thin resistive sheets isolated by dielectric substrate,[4] [5] for example, the Salisbury screen or multilayer absorber. This kind of absorber joins a resistive sheet and a metallic ground plane to balance rejections from the screen. The absorber based metamaterial have the different characteristic like as, Bandwidth enhancement, polarization insensitive, single, double and triple band. The structure of metamaterial absorber has been introducing Dual-band polarization insensitive with absorption lying on at 3.5 GHz and 5.5 GHz Wi-max application. Wi-Max is one of them that give rapid correspondence with a full scope. Both Frequency bands are steady for transverse electric (TE) wave and transverse-magnetic (TM) polarization. The unit cell of proposed metamaterial structure having four small square rings a couple together two circular rings rise on top of the substrate.

In this paper, observed the ultrathin MTM based absorber that is ultrathin in nature. It gives the wide angle absorption mechanism. The structure is consisting of square rings. The result of unit cell structure shows two absorption peak at 3.5 GHz and 5.5 GHz with peak absorption 99.9%.

II. PROPOSED STRUCTURE OF ABSORBER

2.1 Unit Cell

In this section, Fig.1 shows the unit cell structure of Metamaterial absorber with its dimensions. As appeared in the figure the single sided dielectric substrate having a relative dielectric constant of 4.4, tangent loss of 0.025, and thickness of 1.6mm. A compact dual-band metamaterial absorber consists of two metallic layers[6] [7]. The outer square ring having the similar size of the substrate. The Proposed structure of two square rings and two circular rings incorporated with four split square rings. The Both metallic layers separated by dielectric copper (σ=5.8*10^7S/m). After that, the thickness of upper surface is 0.05mm.The outer square ring have been designed to operate at 3.5GHz and inner square rings to opera3 at 5.5 GHz. The dimensions of the absorber structure are illustrated in Table-1.

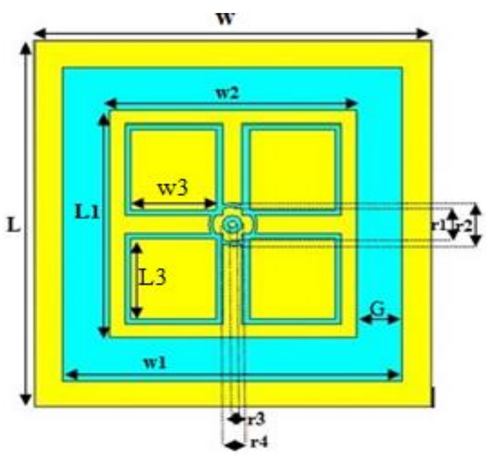

Fig.1-front view of structure with its dimension

Table 1. Dimensions of proposed unit cell

Dimension of structure	**Symbol**	**Value (in mm)**
Width & Length of substrate	W&L	20
Width & Length of outer square	W1	18.6
Width & Length of middle square	W2 & L1	12.5
Width & Length of inner square	W3 &L3	2.2
Inner radius of ring	r1 & r2	1.2 & 1
Outer radius of ring	r3 & r4	0.5 & 0.2
Gap	G	2.4

2.2 *Design Of Unit Cell Array*

In Fig.2 demonstrates the size for the substrate of unit cell is Ws(mm)* Ws(mm)*h(mm). An element of arrays repeated with the periodicity for X and Y plane [8][9][10].

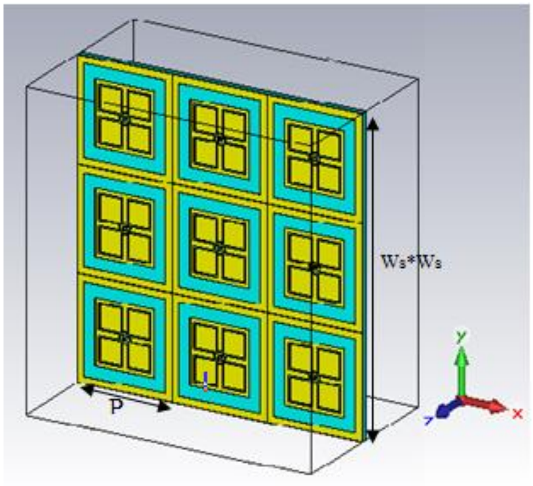

Fig.2-Prospective view of 3*3 unit cell

The geometrical parameters of the absorber arrays element have displays in table-2.

Table 2. Parameters of array structure

Dimension of unit cell	**Ws(mm)**	**P(mm)**	**H(mm)**
Value(mm)	60	20	0.05

III. SIMULATION & RESULTS OF UNIT CELL

3.1. *Reflection And Absorption*

There are three main characteristics of metamaterial absorber [11] such as Absorption, Reflection, and transmission. The frequency characteristics has been calculated by the formula for absorption coefficient.

$$A(\omega)= 1-|S11(\omega)|^2-|S21(\omega)|^2 \qquad (1)$$

In the ground surface, due to the upper copper surface power is neither transmitted nor reflected across the entire frequency range, So $|S21(\omega)|=0$

Initially, the basic equation used to determine the absorption of unit cell structure are shown below.

$$A(\omega)= 1-|S11(\omega)|^2 \qquad (2)$$

where,

A=Absorption

Above access equation, It can be observed the Refection coefficient at 3.5GHz & 5.5GHz resonant frequency for the dual band [12].

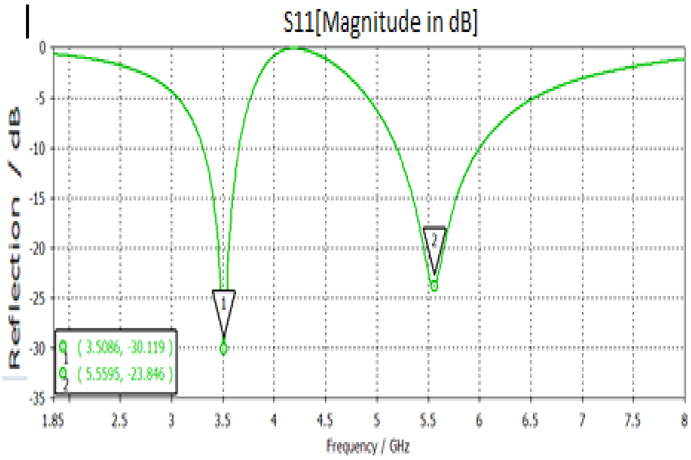

Fig.3- Simulated results of Reflection at 3.5 GHz & 5.5 GHz

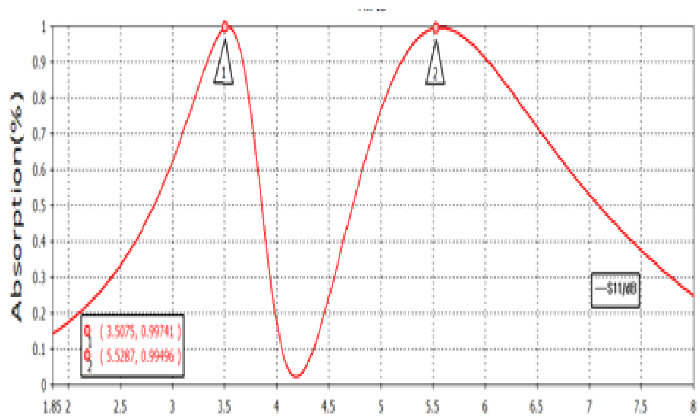

Fig.4- simulated absorption of unit cell

In the experiments, the simulation of Reflection coefficient with periodic unit cell boundary conditions is obtained on CST Microwave studio using frequency domain solver. the metamaterial absorber for the Reflection is being simulated at 3.5 GHz is -30.11dB and at 5.5 GHz is -23.84 dB as shown in Fig.3.The metamaterial absorber both reflection and absorption are obtained at 3.5GHz and 5.5^{0}GHz frequency in fig.4.[13]-[15] .The simulated absorption has demonstrated two distinct peaks at 0.99% and 0.99% for all incident angle.

3.2. Absorption Characteristics of Incident Angle

The simulated results of structure shows between response of appliance and incident angle. EM waves are generally occurrence into absorbers with the incident angle. So, it is important to get the absorption with polarization incident angle.[16] [17].To determine the polarization performance of proposed structure has been observed under different polarization angles ranging from 0^0 to 50^0 in the tread of 10^0. To verifying the angle theta the observed results in Fig.5 and Fig.6 shows a highly incident angle for both TE and TM waves. Which means the magnetic-flux of upper and lower surface is practically unchanged.

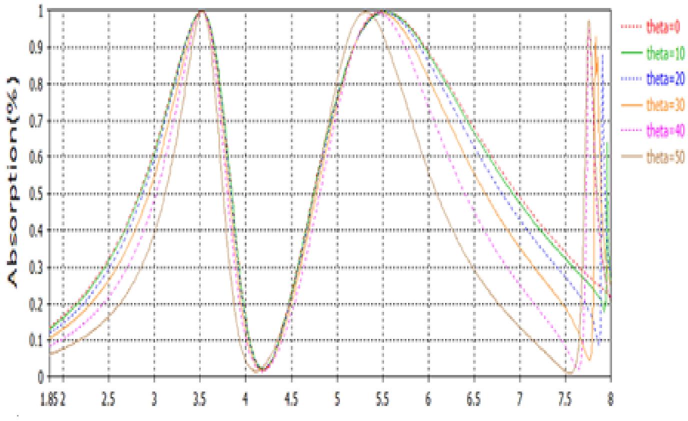

Fig.5- Incident angel variation for TE-mode

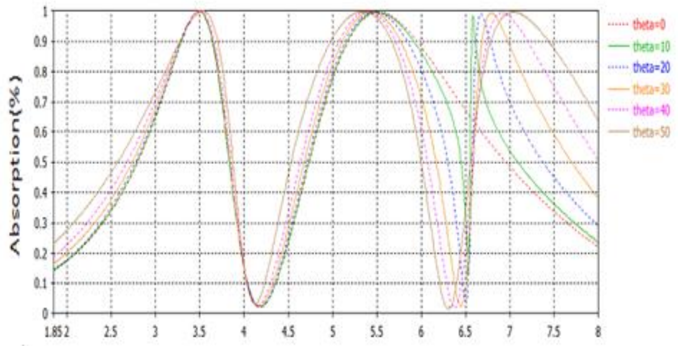

Fig.6- Incident angle variation for TM-mode

3.3 Surface Current

In simulated unit cell design, The surface current distribution has displayed maximum amount of current flow on outer square rings at 3.5 GHz, and at 5.5 GHz shows minimum current flow effects on an inner square and circular rings as illustrate in fig.5(a) and (b)[18]. the surface current circulate around magnetic-field that is causes of strong magnetic resonance and gives high absorbance at this frequency when electric resonance coupled with smaller ring.

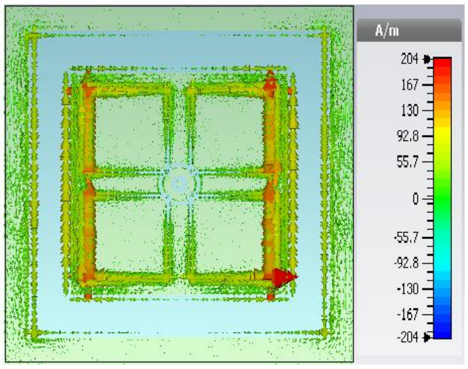

Fig.(a)

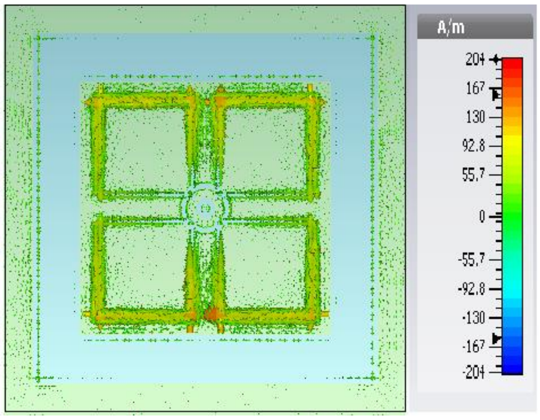

Fig.(b)

Fig.7- Simulated surface current distribution on the front surface (a) at 3.5 GHz (b) at 5.5GHz

IV. CONCLUSION

As a conclusion, The ultra-thin metamaterial absorber with wide incident angle has been designed and analyzed. A dual-band metamaterial absorber has been proposed in order to observe better reflection and maximum absorption. No power signals transmitted in the ground surface[19] [20]. As mentioned above, 99% absorption has been absorb for dual-band. In the simulation of incident angle, signal has been transmitted ranging from 0^0 to 50^0 for both TE and TM waves. The surface current has displayed maximum effects on the edge of outer square rings at 3.5 GHz, and at 5.5 GHz surface currents effects on inner square and circular rings as illustrate in fig.5.

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