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PERFORMANCE ANALYSIS OF DIPOLE ANTENNA WITH DOUBLE SPLIT RING RESONATOR

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Abstract— *In this paper, a beam-tilting appliance for dipole projections utilizing the metamaterial unit cells is designated. Beam glance is based on the phase alteration occurrences executed using metamaterial unit cells. A metamaterial medium is designed to provide different refractive indices The metamaterial is integrated on the substrate of a dipole antenna for angling the antenna beam that has an operating frequency of 60 GHz. There is an increase in gain occurs due to the loading of the metamaterial .The metamaterial medium does not affect the antenna matching and bandwidth over the frequency range of operation. Here, the radiation beam from the antenna will be in a specific direction with the inclusion of metamaterial loading. The unit cell was first characterized by measuring its S-parameters. Several multi bands are obtained from this design over the frequency range of 57-64 GHz. U and V band applications can be utilized due to the multiple narrow bands in the frequency range of operation.*

Keywords : *Beam Tilting, Metamaterial, Refractive Index.*

I. INTRODUCTION

A performance to transfer the radiation beam from a planar antenna in a specific direction with the inclusion of metamaterial loading. The metamaterial H-shaped unit-cell structure is configured to provide a high refractive index which was used to implement beam tilting in a bow-tie antenna [8].A beam-tilting technique for planar dipole antennas using gradient refractive-index metamaterial (GRIM) unit-cells. The GRIM unit-cell comprises of a stub-loaded I-shaped resonant structure that is directly integrated onto the dipole antenna. The antenna exhibits 4-dB gain enhancement and S11 better than −10 dB from 57–64 GHz[11]. An improved procedure for extracting the effective constitutive parameters of a metamaterial is derived. The procedure invokes the Kramers–Kronig relations to ensure the uniqueness of the solution. The applicability and limit of the presented algorithm are explored by observing how the effective parameters of a metamaterial slab converge as its thickness is increased [10].A two-sectioned metamaterial medium is designed to provide two different effective refractive indices in each of its parts. This metamaterial is integrated on the substrate in front of a printed dipole antenna for tilting the antenna beam that operates at the frequency of 60 GHz and also a gain enhancement of 2.4 dB is observed [13].A novel technique to enhance the gain of the basic monopole antenna by using broadband gradient refractive index (GRIN) metamaterial. A seven GRIN lens is placed on the omnidirectional printed basic monopole antenna, perpendicularly. Due to the GRIN lens, the peak gain of the basic monopole antenna is increased by 5.3 dB at 8.8 GHz [12]. A metallic planar particle, that will be called spiral resonator (SR), is introduced as a useful artificial atom for artificial magnetic media design and fabrication. Experimental confirmation of NMPM and LHM behavior using SR's is also reported [9]. Double split ring resonator consists of an inner square with a split on one side embedded in an outer square with a split on the other side. The inner ring and the outer ring are made separately with the parametric values mentioned in the table. Both rings are made up of copper for a good conductivity. A dipole antenna commonly consists of two identical conductive elements such as metal wires or rods, which are usually bilaterally symmetrical. The feed point impedance of a dipole antenna is sensitive to its electrical length and feed point position. Therefore, a dipole will generally only perform optimally over a rather narrow bandwidth, beyond which its impedance will become a poor match for the transmitter or receiver (and transmission line).

II. DESIGN OF METAMATERIAL

Double split ring resonator consists of an inner square with a split on one side embedded in an outer square with a split on the other side. The unit cells are designed on the FR-4(lossy) substrate. The structures are simulated using the HFSS software.

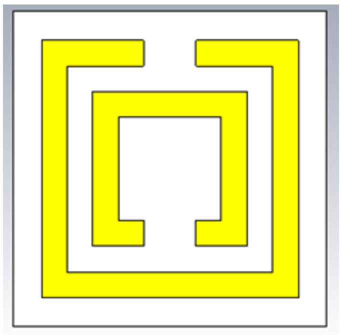

Fig.1 Unitcell

The parameters are shown as follows, the gap is to be 0.1,the rings and the split width is 0.05 and the height is to be 0.5.The substrate is to be of 14×14 mm. Metamaterial structure is designed as per the dimensions, both the structures provide different refractive indices due to the variation in the structure.

III. DESIGN OF AN ANTENNA

The two sectioned metamaterial medium is placed in front of the printed dipole antenna.FR-4 (Lossy) substrate is used for the design of antenna with the thickness of 0.254 mm. The general parameters of the antenna is mentioned on the schematic diagram. The dimensions of the antenna are given as follows, the height of the antenna is 1.4 and the width is 0.2mm.The antenna is structured as shown below,

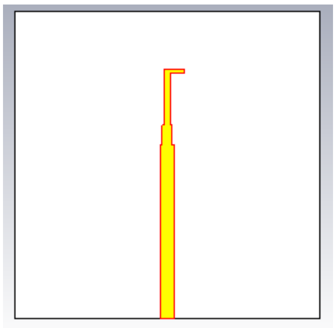

Fig.2 Top view of the antenna

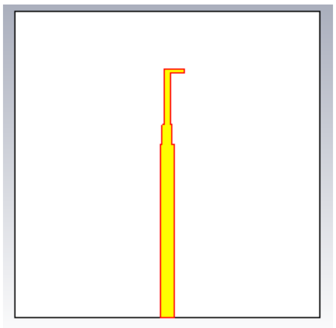

Fig.3 Bottom view of the antenna

The overall structure of the antenna along with the metamaterial placed infront of the antenna is designed using the following parameters.

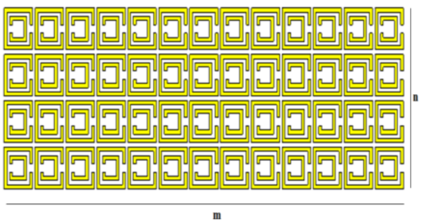

Fig.4 Metamaterial Structure

The total structure is designed with copper,a good conductor as well as cheap and convenient on the substrate of FR-4(Lossy).

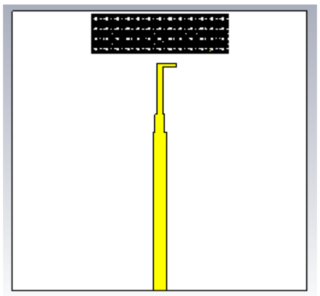

Fig.5 Top view of the Antenna with DSR

After the completion of the design ,the boundary conditions are all given with the port assigned at the bottom of the bottom of the antenna .Lumped port is fed into the antenna .Due to the lumped port reasonable results can be obtained.If the frequency is low enough or the excitation is applied at suffiently small area,then the wave can be described by some voltage or current.

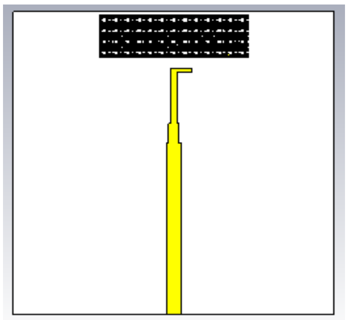

Fig.6 Bottom view of the Antenna with DSR

IV. RESULTS AND DISCUSSION

First, the double split ring resonator is designed as in Fig 7.The obtained S-parameter for the DSR is Shown below. For the Return Loss, the result will be obtained as a wide band. The wide band lasts up to 64GHz.But, when it is loaded into the antenna it creates multiple narrow bands between 57 – 64GHz.

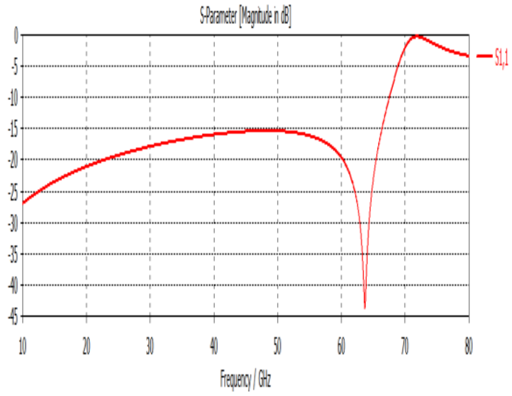

Fig.7 Return Loss for DSR

For Transmission Coefficient ,the result will be as a multiband as shown below,

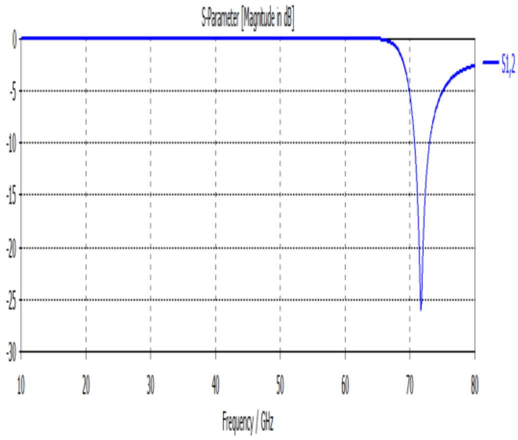

Fig.8 Transmission Coefficient for DSR

The antenna without the metamaterial is proceeded after the completion of the metamaterial medium. The antenna alone provides narrow bands beyond 64GHz. From the results of metamaterial also, it is shown that the transmission will be good up to 72 GHz.

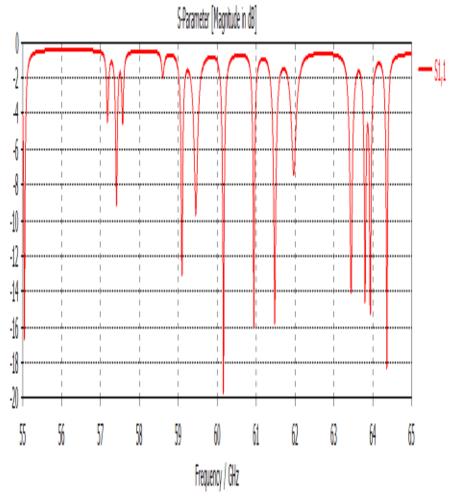

Fig.9 Return loss for the antenna

The Far field pattern provides the angle deviation of the antenna beam. The tilt angle without the metamaterial medium is given below,

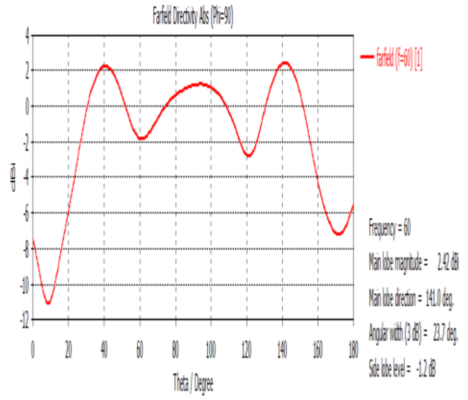

Fig.10 Far field pattern for antenna

For 60 GHz, the gain is maximum at the peak of 141 deg. It is considered as an initial angle .When the metamaterial medium is added there it will provide an angle deviation with the increased gain. After the antenna without metamaterial process has done, then the result of the whole structure is as follows. The comparison table.1 shows with the structure of the antenna alone, with both unit cells, double split ring alone and Spiral resonator alone are analyzed.

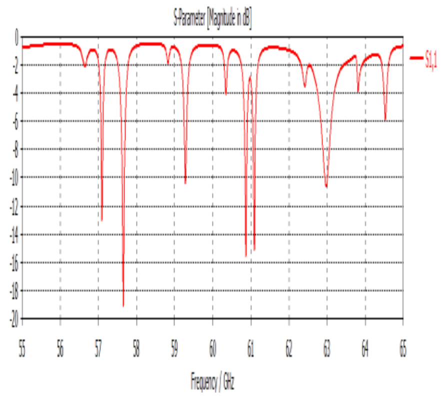

Fig.11Return loss for the whole structure

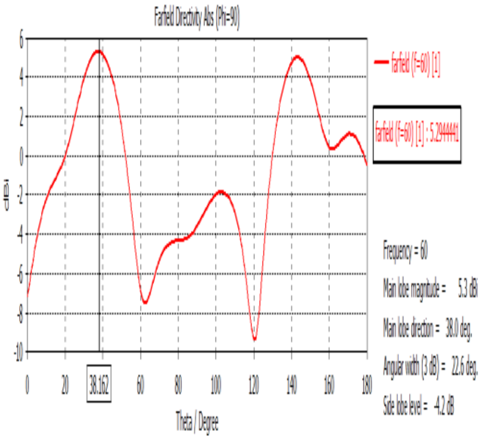

Fig.12 Antenna with DSR

The following table shows the comparison between the variation in structure of the metamaterials used in front of the antenna.

Table.1 Comparison Table

Structure	Return Loss (dB)	Gain(dBi)	Tilt Angle(θ)
Dipole Antenna	**-20**	2.42	141
Antenna with Unit cells	-16	2.08	144
DSR only	**-20**	**5.3**	38 (-103)
Spiral only	-9	1.5	34 (-107)

V. CONCLUSION

A metamaterial medium with the application of beam tilting along with the dipole antenna operating at a frequency of 60 GHz has been designed using the Ansys HFSS software. The performance that has been used to gadget the beam leaning is based on the metamaterial medium that is composed of unit cells that provide a significantly dissimilar refractive index compared to each other. The whole metamaterial structure is printed in front of the antenna radiator on the same substrate and does not affect the antenna matching. Further, the frequency range lies in the U and V bands of the microwave spectrum, hence the applications of dual band can be utilized.

VI. REFERENCES

[1] C. Park and T. Rappaport, “Short range Wireless Communications for Next Generation Networks: UWB, 60 GHz millimeter wave WPAN and Zigbee,” IEEE Wireless Communications, vol. 14, no. 4, pp. 70-78, Aug. 2007.
[2] Maltsev, R. Maslennikov, A. Sevastyanov, A. Lomayev, A.Khoryaev, A.Davydov and V. Ssorin, "Characteristics of Indoor Millimeter-Wave Channel at 60 GHz in Application to Perspective WLAN System," European Conf Antenna Propag (EuCap), pp.1-5, April 2010.
[3] H. T. Friis, “A note on a simple transmission formula,” Proc. I.R.E. and Waves and Electrons, pp. 254–256, May 1946.
[4] D. A. Fittipaldi, S. Skafidas, and M. Luise, “IEEE 802.15.3c medium access controller throughput for phased array systems,” in Proc. 18th Annu. IEEE Int.Symp.Personal,Indoor,Mobile Radio Commun.(PIMRC'07), Athens,Greece, pp. 1–5, Sep. 2007.
[5] K. Hosoya, N. Parsad, K. Ramachandran, N. Orihashi, S. Kishimoto, S.Rangarajan and Kenichi Maruhashi, "Multiple Sector ID Capture (MIDC): A Novel Beamforming Technique for 60-GHz Band Multi-Gbps WLAN/PAN Systems," IEEE Trans Antenna Propag. vol. 63, no. 1, pp. 81-96, Jan 2015.
[6] P. Deo, D. Mirshekar-Syahkal, L. Seddon, S. E. Day and F. A.Fernandez "60 GHz id crystal phased array using reflection-type phase shifter," European Conf. on Antennas and Propag., pp. 927--929, April 2013.
[7] C-H. Tseng, J-C. Chen and T-H Chu "A low-cost 60-GHz switched-beam patch antenna array with butler matrix network,” IEEE Lett. Antenna. Propag.vol.7,pp.432--435,2008.

[8] Dadgarpour, B. Zarghooni, B. S. Virdee and T. A. Denidni, "Beam Tilting Antenna using Integrated Metamaterial Loading," IEEE Trans Antenna Propag. vol. 62 no. 5, pp. 2874-2879, May 2014.
[9] J. D. Baena, R. Marques, and F. Medina, „"Artificial magnetic metamaterial design by using spiral resonators", Phys. Rev. B 69 (2004) 69–014402.
[10]Z. Szabo, G.-H. Park, R. Hedge, and E.-P. Li, "A unique extraction of metamaterial parameters based on Kramers–Kronig relationship," IEEE Trans Microw. Theory Tech. vol. 58, no. 10, pp. 2646-2653, Sep. 2010.
[11] Dadgarpour, B. Zarghooni, B. S. Virdee and T. A. Denidni, "Beam- Deflection Using Gradient Refractive-Index Media for 60 –GHz End-Fire Antenne," IEEE Trans Antenna Propag. vol. 63 no. 8, pp. 2874-2879, August 2015.
[12] Rahul Singha and Damera Vakula "Directive Beam of the Monopole Antenna Using Broadband Gradient Refractive Index Metamaterial for Ultra-Wideband Application" IEEE access vol 5,May 2017.
[13] Dadgarpour, B. Zarghooni, B. S. Virdee and T. A. Denidni, "Millimeter wave antenna using two sectioned metamaterial medium," IEEE Trans Antenna Propag. vol. 62 no. 5, pp. 2874-2879, May 2015.