Study on Multi-Band Circular Antenna for Different Applications

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***Abstract-** As we know that antenna is one of the very important component of any wireless communication, with increasing demand for multiband application, requirement of such antenna is highly desirable. Due to its range of favorable conditions over conventional antenna, such as minimal effort, convenient to feed, mild in weight, easy production system and their compelling radiation attributes. In this paper, the effect of an electromagnetic band-gap (EBG) Structures on the implementation of microstrip antenna and its review is presented. We also investigate the effect of circular patch in the microstrip antenna design. The guideline purpose of this manuscript is to get an inside of circular EBG structure to work it as a resonator and diverse techniques to upgrade its performance parameter along with multiband applications.*

***Index Terms-** Multi-Band, Performance Parameters, VSWR, Axial Ratio.*

I. INTRODUCTION

Microstrip antenna is in demand with the researchers due to its various advantages over conventional antenna design viz. low cost of fabrication, simple feeding techniques, light weight and compactness. With the increase in average number of device operated in a house hold or office premises requirement for multi-band antenna is highly desirable in modern communication system . There are several type of microstrip antenna which is accepted in designing Multi-band antenna's. Furthermore, different design methods for microstrip antenna is described in this paper which can also be applied with different types of antenna other than microstrip antanna. The contents of the paper are organized in following manner. Section II, explain the fundamental concepts and different equations associated with the microstrip structure especially for circular patch antenna. Section III discuss the diverse consequences obtained by various antenna design. And finally, a conclusion is drawn in section IV.

II. THEORY OF MICROSTRIP LINES

The basic theory of circular patch antenna is based on three part viz. circular patch, substrate and ground plane just like any rectangular patch antenna, matelic patch is placed on top and ground plane on bottom and dielectric substrate material is in between the patch and ground plane as shown in figure 1.

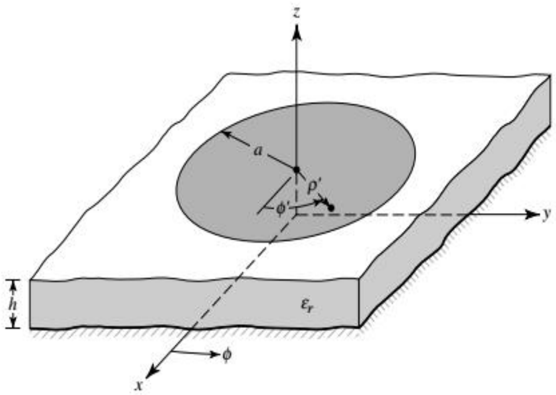

Figure 1. Basic circular patch antenna.

The basic CPA associated with the resonant frequency for TEM_{mn0} mode is given by

$$(f_r)_{mn\,0} \cong \frac{1}{2L\sqrt{\varepsilon\mu}}\left(\frac{u'_{mn}}{a}\right) \qquad (1)$$

Where x'_{mn} is the zeros of the bessel function $J_m(x)$, which determine the order of the resonent frequency, $'a'$ represents the radius of circular patch and other symbol are having standard meaning. The initial four value of u'_{mn} is given [1] as:

$$u'_{11} = 1.8412 \qquad (2.1)$$

$$u'_{21} = 3.0542 \qquad (2.2)$$

$$u'_{01} = 3.8318 \qquad (2.3)$$

$$u'_{31} = 4.2012 \qquad (2.4)$$

Based on equation (1) and (2.1,2.2.2.3 and 2.4) the TEM_{110} and its resonant frequency is given as:

$$(f_r)_{110} \cong \frac{1.8412}{2\pi a\sqrt{\varepsilon\mu}} = \frac{1.8412\ c_0}{2\pi a\sqrt{\varepsilon_r}} \qquad (3)$$

Where c_0 is the speed of light in vacuum, when we include fringing effect, the effective radius of circular patch is modified and represented by:

$$a_e = a\left\{1 + \frac{2h}{\pi a\,\varepsilon_r} ln\left(\frac{\pi a}{2h}\right) + 1.7726\right\}^{\frac{1}{2}} \qquad (4)$$

Thus the effective resonant frequency is given by:

$$(f_{\mathrm{r}})_{110} \cong \frac{1.8412}{2\pi a\sqrt{\varepsilon\mu}} = \frac{1.8412\ c_0}{2\pi a_e\sqrt{\varepsilon_{\mathrm{r}}}} \quad (5)$$

The basic design of CP antenna initiate with ε_{r}, f_{r}(in Hz) and h (in cm) and after that we find the measurement of circular patch using by formula:

$$a = \frac{F}{\left\{1+\frac{2h}{\pi a\,\varepsilon_{\mathrm{r}}}ln\left(\frac{\pi a}{2h}\right)+1.7726\right\}^{\frac{1}{2}}} \quad (6)$$

Where,

$$F = \frac{8.791\times10^{9}}{f_r\sqrt{\varepsilon_{\mathrm{r}}}} \quad (7)$$

III. REVIEW OF PREVIOUS PAPER

In this part we present some of the latest manuscript based on Patch anrenna is reviewed.

Md. Asaduzzaman, Reefat Inum, Md. Sabbir Hossain, Muhammad Abdul Goffar Khan "On the Design of Effective EBG Structures to Model Highly Efficient Rectangular Patch Antenna for Wireless Applications', IEEE International Conference on Robotics,Electrical and Signal Processing Techniques (ICREST) 2019 [1].

This manuscript discuss the relative analysis of radiation parameters of various rectangular patch antennas with quarter wave feed line. Star shaped and fan shaped Electromagnetic Band Gap (EBG) are integrated independently on base plane of each antenna. Resonant frequency detained for the designed antennas is 5.25 GHz. The projected fan shaped EBG based antenna gives a bandwidth of 244 MHz used for wireless applications.

Guo-Ping Gao, Bin Hu*, Shao-Fei Wang, and Chen Yang, "Wearable Circular Ring Slot Antenna with EBG Structure for Wireless Body Area Network",. Antennas and Wireless Propagation Letters IEEE on 2018 [2] : This paper exhibits a wearable approximately ring slot microstrip antenna with electromagnetic Band-Gap (EBG) design for wireless body area network (WBAN) application The measured bandwidth of the projected antenna is seen to be 2.28-2.64 GHz, which covers the 2.4 GHz Industrial Scientific Medical (ISM) band.

Xiaoyan Zhang, Zhaopeng Teng, Zhiqing Liu, and Bincheng Li. "A Dual Band Patch Antenna with a Pinwheel-Shaped Slots EBG Substrate". Hindawi Publishing Corporation International Journal of Antennas and Propagation Volume 2015, Article ID 815751 [3]:

Here a dual band microstrip patch antenna is presented with pinwheel-shaped electromagnetic band-gap (EBG) design. The simulation results give dual bands of bandwidth 130 MHz and 140 MHz in a frequency range of 4 GHz to 8 GHz. The anticipated EBG antenna has eight slots of pin-wheel shape which gives better results than that of conventional mushroom-like EBG in square shape. hence here we can see that the introduction of pin-wheel EBG, the -10 dB impedance bandwidth is improved.

Weiwei Xu, Junhong Wang, "A Novel Microstrip Antenna With Composite Patch Structure for Reduction of In-Band RCS ". IEEE Antennas And Wireless Propagation Letters, Vol. 14, 2015 [6]:

In this document an exceptional sort of composite patch antenna is exhibited, in which the mushroom-like electromagnetic band-gap (EBG) structure is fabricated on the customary metallic patch. In light of the high impedance property of the EBG structure, the dispersing fields from given EBG structure and the rest of aerial structure are out of phase with each other and in this way cancels one another. The mushroom-like patch EBG displays a characteristic low in-band radar cross area (RCS) property and keeps the minimal two-dimensional size as the average microstrip antenna. When transmitting, the composite fix as a whole demonstrations in light of the fact that the emanating a piece of the radio wire; though dissipating, the composite patch arial will extensively downsize the in-band RCS among main scattering beam direction and also the most reduction will reach 8 db once plane wave is natural event from normal direction.

IV. CONCLUSION

In this paper, a thorough examination is displayed on the electromagnetic band gap structure, their various plans, and dynamic switch up to the present uniplanar plot. For the RF and microwave examiners, the EBG expressing is a hot research bearing to deal with our various issues that damage the helpful capability of a system. A basic microstrip patch antenna is a fundamental component of any correspondence system to get and transmit electromagnetic imperativeness. Being absolutely planar, microstrip Antennas are uncommonly engaging and for the most part used for applications in range of millimeter wave starting from GHz. From the reference of 11 International Journal on Antennas, wave propagation and communication we understand the basic behavior of the EBG structure, here we see the various type of EBG structure which is capable to increase the bandwidth, gain and different performance parameter of any patch antenna. We are expecting a detailed view of a Multi-Band antenna which work on 4G, 5G and in WiFi for automotive use by the application of EBG structure. The Proposed paper is compact study guide giving insight of the wide operational bandwidth which can be achieved by using properties of circular EBG antenna

geometry. We are also expecting very small polarization loss for EBG technique and has great effect on polarization also. This composing study will obviously set a reason about the recurring pattern of EBG investigation and will be helpful for microstrip patch antenna design.

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