http://www.jctjournals.com

ISSN(ONLINE):2278 - 3814

Volume-11, Issue03, March, 2022

JOURNAL OF COMPUTING TECHNOLOGIES (JCT)

International Journal

Page Number: 01-09

A Literature Survey On Different Bow-Tie Slot Antenna

Narendra Kumar Tripathi[1], Dr. Arvind Kourav [2], Prof. Nehul Mathur[3]

[1]M.Tech Scholar, [2]Professor,[3]Assistant Professor,

[1,2,3]Department of Electronics & Communication Engineering

[1,2,3]Bhopal Institute of Technology, (BIT), RGPV, Bhopal (M.P), INDIA,

***Abstract*—In this survey paper- A bow tie antenna is made from bi-triangular sheet of metal. It is used for all UWB applications like Wi-Fi, ground penetrating radar, wireless and microwave imaging applications. But Micro strip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane. The antennas may be easily mounted on missiles, rockets and satellites without major alterations. The bow tie antenna is resonant at multiple frequencies of 2.4,3.6, 3.9 & 4.9GHz which are unlicensed band and used for wireless applications. Other hand a Micro strip patch antenna having the operational frequency of 1.8 GHz, 3.8 GHz and 5.2 GHz VSWR bandwidth and return loss bandwidth up to - 23.75db has been obtained. So through bow tie antenna get four frequencies at four different levels which are used for wireless applications.**

Keywords*—*Microstrip Circularly polarized antennaMicrostrip antennaSlot antennaSAR and WBANCPW-fed, Bow-tie arm, Tri-band, Gain

I. INTRODUCTION

Antenna is a key device for any wireless communication system. An antenna is a means of radiating or receiving radio waves, this definition is given in IEEE. Or we can say that antenna acts as an interface for electromagnetic energy, propagating between free area and guided medium. Satellite and Wireless communication has been developed quickly within the last few years and it has left a great impact on human life. Recently the trend in commercial and government communication systems has led to developing low value, low profile, minimal weight, and broadband antennas that are able in the maintenance of the high performance over a very huge range of frequencies. The trend in technology has centered a lot of effort in the designing of Microstrip antennas which are referred as patch antenna. With an easy geometry, patch antennas provide several benefits not usually given in different antenna configuration. As an example, they are terribly low profile, simple and low cost, light-weight weight to fabricate exploitation modern computer circuit board technology, compatible with MMIC i.e. the (microwave and millimeter-wave integrated circuits) and have the facility to adapt to platelike and non-planar surfaces. In addition if chosen once the form and operational mode of the patch, designs become very versatile in terms of polarization, pattern, operating frequency, and impedance.The variability in design that's attainable with Microstrip antenna in all probability exceeds that of the other kind of antenna element. Lower Gain of Microstrip antenna is one of the major disadvantages that restrict its widespread use. If the Gain of Microstrip antenna could be higher, it would be very useful for recent trend of wireless communication. Many researchers have successfully overcome the disadvantage of having low gain of Microstrip antenna by modifying their shape, size or introducing additional element making appropriate wire free communication.

For the simulation Microstrip antenna with ground plane by using CST microwave studio2011 and Ansoft HFSS-13, which is based on finite difference time domain method (FDTD) is one in every of the most imperial electromagnetic software that allows to solving for radio and microwave application.

Microstrip antenna has been widely used in many modern communication systems for its small size, low cost, and light weight. Coaxial feeding is a way to feed the Microstrip antenna and exhibits numerous advantages. For instance, the spurious feed radiation can be isolated due to the introduced circular ground plane between the coaxial feed line and patch. Lately, Microstrip antenna has been noticed a lot. However, the improved gain, enhanced bandwidth and directivity of this kind of antenna need to be further investigated for the practical applications. The horn antenna gave a good return loss and narrow radiated beam is obtained by a periodic corrugated metallic plate.
A wave guide slit-array antenna has enforced with high gain and narrow beam-width by utilizing sub wavelength periodic grooves, and also the physical mechanism is studied. However, there are some constraints for the above antennas in the actual applications, like the high cost and not being easy to integrate with other microwave devices. The improvement of the Bandwidth is one amongst the foremost design considerations for many practical applications of antennas. When we talk about dielectric resonator antennas and the Microstrip antennas, a

Copyright © 2022. JCT Publications. All Rights Reserved

ISSN(ONLINE):2278 – 3814

comparison was made and as a result the Microstrip antennas do have their own disadvantages or we can say limitation such as narrow bandwidth, lower gain, lower power handling capability etc. For that reason, slotted planar antennas are preferred over Microstrip and conventional antennas.Many techniques have been developed to extend the bandwidth and procure multiband response by the scientists for an antenna. One of the approach which enhanced the bandwidth was making MSA by using different types of feeding technique. The recent advancements in wireless communication industry, especially in the area of mobile communication and wireless data communication, have led to the increase in the requirement for multi band antennas which are here to support the MSA's design or its study.

A. ***Bo –Tie Antenna***

The two triangular pieces of stiff wire or 2 triangular flat antenna metal plates, organized within the configuration of a bowtie, the triangle'sapexhave the feed point at the gap between them. As a simple (and non-manufacturable) infinitely wideband antenna, let's consider an infinite bow-tie antenna: infinite bow-tie antenna.

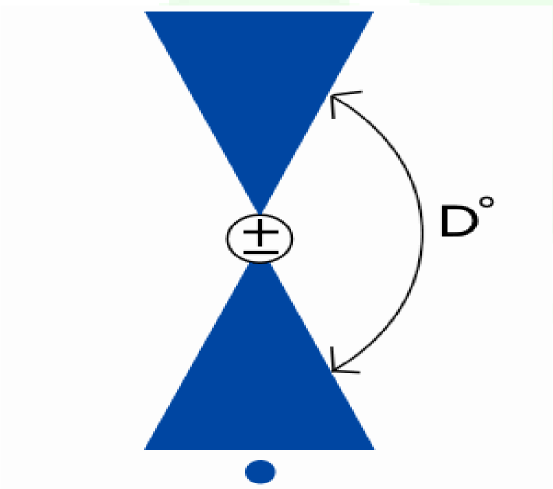


Fig.1. Infinitely Long Bow-Tie Antenna.

II. LITERATURE SURVEY

In this Singh, et.al (2021), In this Research work presented a printed compact wideband circularly polarized bowtie slot antenna (WCPBSA) is proposed and presented for wireless body area network (WBAN) applications. The proposed FR4 dielectric based compact antenna has been designed by etching a wide bowtie shaped slot in the ground plane along with a pair of thin slits inserted in the ground plane. The proposed slot antenna is excited by a 50 Ω feedline with dual horizontal stepped stubs, protruding in opposite directions in the slot, which excites dual orthogonal modes to achieve a wide simulated 3-dB axial ratio bandwidth (ARBW) of 48.14% in 4.1 – 6.7 GHz frequency band with approximately identical 10 dB return loss (RL) bandwidth. The proposed WCPBSA is also experimentally verified on human body and observed to be of low specific absorption rate (SAR) value of 0.975 W/kg over 10 g of human tissues and a measured gain of 4.1 dBi at frequency 5.8 GHz. Then proposed WCPBSA of size 20 × 20 × 0.8 mm3 is designed, fabricated and the measured results are verified and validated with simulated results

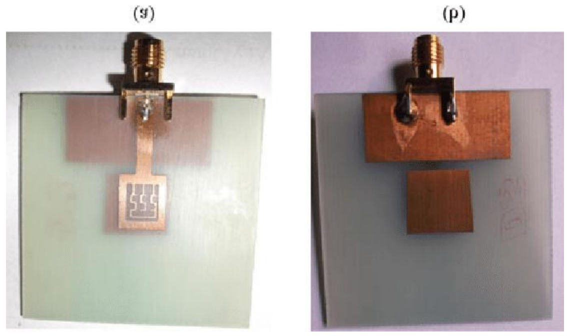
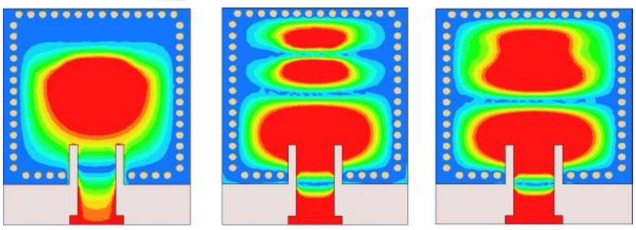


Fig. 2.1 Fabricated prototype of WCPBSA (Antenna 6).

Bollavathi, et.al. (2020), In this Research work presented an extensive study of a wideband slot antenna based on the dumbbell-shaped slot, shorting-vias and SIW cavity is discussed in this research work. The SIW cavity is stimulated by microstrip line feed for planar integration. Due to the loading of shorting-vias in the middle of SIW cavity, the individual bandwidth of the lowest mode is moved upward and coupled with the higher-order resonances, which increases the bandwidth of the antenna. To improve the bandwidth further, a short rectangle slot is appended at each end of the dumbbell-shaped slot. The fabricated sample has been tested to validate the presented design. The measured results show that the fractional bandwidth is 22.4% for the presented antenna. The antenna also consigns with a flat gain in the band of interest and exhibits low cross-polarization level at all the resonant frequencies. Furthermore, shorting-vias approach surpasses the narrow bandwidth of a conventional SIW. Further, the presented design can be readily extended to a higher number of cavities [2].



(a) (b) (c)

Fig.2.2 E-field distributions of the SIW cavity (a) 6.9 GHz, (b) 10.25 GHz, and (c) 13.1 GHz.

Copyright © 2022. JCT Publications. All Rights Reserved

ISSN(ONLINE):2278 - 3814

Dayo, et.al. (2019, March), In this Research work presented a planar bow-tie slot antenna for tri-band wireless communication application has been presented and studied in this research work. The tri-band characteristics of the presented antenna have been achieved by setting up the proper dimensions of slots. Moreover, the antenna achieves the substantial fractional impedance bandwidth 25.8%, 13.3%, 9.9% and high gain 6.9dBi at C-band, substantial gain of 3.96dBi at X-band, acceptable gain of 0.49dBi at WIAMXband. The antenna has been designed and simulated through the electromagnetic solver software HFSS 13.0. The simulation results validates the designed antenna is a suitable contender for WIMAX, C-band and X-band wireless communication applications [3]

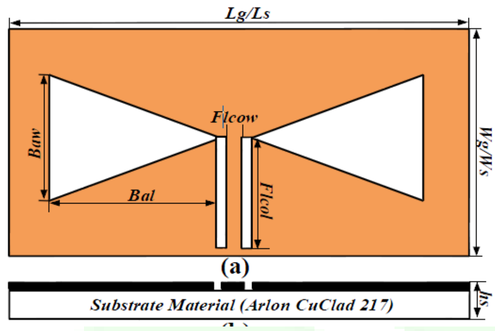


Fig. 2.3 (a) Top and (b) Side view of proposed BTSA.

Choudhary, et.al.(2018, December), Thepresented antenna shows a wide band and cover Wi-Fi and Wi-Max ranges whose frequencies is between 2 to 6 GHz discussed in the figure 5. The range of presented design covers the Wi-Fi and Wi-Max range. The Gain of proposed design at 2.33 GHz frequency range that is 7.8246 dB in the wide band gain also above 6dB. Also shows the good result in terms of return loss that is (S-11) -35dB as well as VSWR that is 1.08. In future try to improve the gain as well as directivity of the design. In future apply soft computing to enhance the present result with the help of neural network and other machine learning techniques [4].

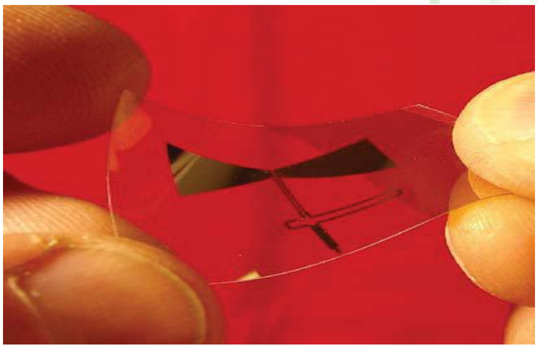
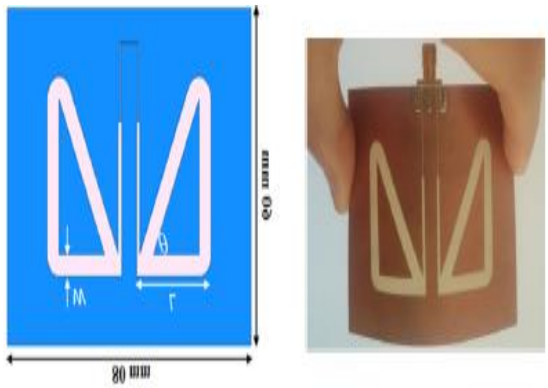


Fig. 2.4 Flexible Bow- Tie antenna [04]

Sallam, Mai O. et.al, (2017), In this research article researchers focus on wideband antenna with fixable property. From 2 slotted right-angle triangles fed by a coplanar wave guide transmission line, the antenna is made. Here a model is being characterized, designed and fabricated through an experiment. The measurements are revealing good agreement with simulations. WLAN is in 2.4 and 3.65 GHz and WiMax is in 2.3, 2.5, and 3.5 GHz spectra, when taken as a whole impedance bandwidth of 1.79 GHz (57.7%) and 1.46 GHz (49.7%), respectively. The radiation of the antenna is bidirectional with gains of 6.30 and 5.09 dB for the free space and brick wall versions, respectively [5]



(a) Shows structure of CPW feed based bow tie antenna (b) shows the flexibility on bow tie

Fig. 2.5 Structure of Bow-Tie flexible antenna

N. et. al. (2016),[4] In this Research work presented a multiband Bow Tie antenna with circular arm and fractal geometry has been studied. The multiband operation is achieved by Apollonian Gasket of Fractals which are the combination of mutually tangent circles. The antenna is designed up to 3rd iteration in which best result is obtained for second iteration. UWB band is obtained by cutting two circular slots in the ground. Four resonating frequencies are obtained with very low reflection co efficient. The antenna is fabricated using etching process and tested using VNA. This presented antenna shows a good omnidirectional radiation pattern. Radiation efficiency is more than 40% in each case. It is simulated by in ZELAND IE3D 15.3 software and validates the purpose of this antenna to be used in satellite, cellular mobile and radar applications.[6]

Copyright © 2022. JCT Publications. All Rights Reserved

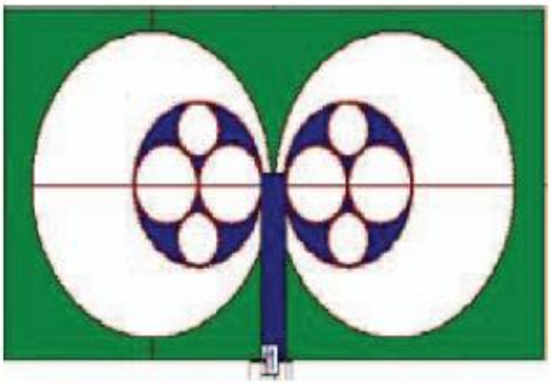


Fig. 2.3 Describe the structure on Apollonian Gasket Bow Tie antenna

Shao, et. al. (2015), In this Research work presented a textile-based broadband elastic RFID tag antenna was been fabricated, designed, and tested. It was demonstrated that the designed antenna achieves a bandwidth of 263MHz in free space, and more importantly, it maintains its tuned behavior when placed on dielectrics with varying permittivity. Different versions of the designed tag antenna were fabricated and tested. [7].

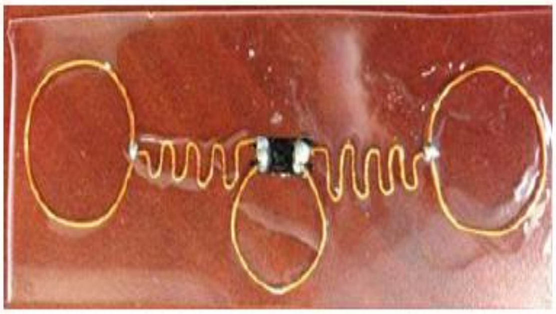


Fig. 2.4 Textile-based RFID

T. L. Chuan (2014), [08] In this Research work presented a novel dual-band configuration of a CPW-fed slot antenna using a signal strip, 2 conducting strips and bow-tie-shaped slots has been projected and enforced. Here the effect of 2 geometrical parameters on the antenna is been studied. For 2.4/5.2/5.8 GHz antenna which is suitable for wireless local area network operation bands with simple tuning parameters. The measured result are showing a positive agreement here with simulated results. [8]

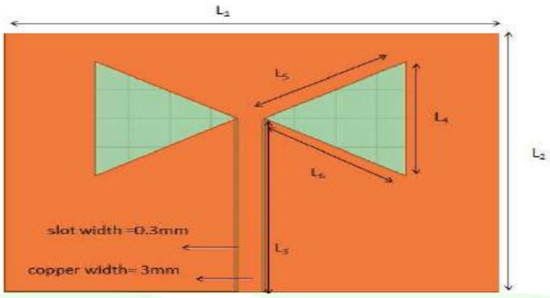


Fig. 2.6 Shows the Bow Tie shaped Slot antenna

2.1 Comparison Table of different shape antenna

S. No.	Year	Antenna (Shape/ Modification)	Frequency Range	S - Parameter	Band Width	No of Bands
1	2021	wearable antenna	5-6 GHz	5.3GHz = -19db	2.9 GHz	1
2	2020	bowtie-shaped slot antenna	9-11 GHz	9.5,10.10GHz = -25db	2 GHz	2
3	2019	bow-tie slot antenna	2-4 GHz	2.5GHz = -17db	2GHz	1
4	2018	flexible antenna	1-8 GHz	1.5GHz = -5db	7GHz	5

 Copyright © 2022. JCT Publications. All Rights Reserved

5	2017	slot configuration in a single metal sheet	2-4 GHz	2.5,3,3.9GHz = -14db	2GHz	3
6	2016	Log-periodic dipole array antenna	2-6.5 GHz	2.5 GHz = -16dB 5-6 GHz = -18dB	0.6 GHz 0.8 GHz	2
7	2016	Bow Tie Antenna	3-11 GHz	2.5-9GHz= -53db	7.5 GHz	1
9	2015	Asymetric coplanar strip antenna	1.5-7 GHz	2-2.6GHz=-24 dB 3.5-6GHz=-32 dB	200MHz & 2800 MHz	2
10	2014	Bow Tie antenna	2-7 GHz	2.2-2.7 GHz=-23 dB & 5-6 GHz=-25 dB	0.5 GHz & 1 GHz	2
11	2014	ACS-Fed Dual Band Antenna	2-8GHz	2.4GHz = -29dB & 3.0–7.6GHz = -38 dB	400MHz & 4600 MHz	2
12	2011	monopole antenna	1-4 GHz	2.1-2.7 GHz = -27 dB	0.6 GHz	1
13	2012	rhombus slot antenna	1-7 GHz	2.2-3 GHz =-24 dB & 4.8-6.2GHz =-30 dB	0.8 GHz & 0.4 GHz	2
14	2010	BOw Tie slot antenna	2-6.5 GHz	2.3-3.7 GHz =-38dB & 4.9-6.2 GHz=-38db	1.5 GHz & 1.3 GHz	2
15	2010	flexible antenna	1.5-3.5 GHz	2.25-2.8GHz=-28 dB	0.65 GHz	1
16	2008	Bow Tie antenna	0-30 GHz	11-22GHz=-26 dB	11 GHz	1
17	2007	flexible antenna	0-7 GHz	…………………	130MHz 500MHz 200 MHz	3
18	2006	Bow Tie antenna	0-12 GHz	3.5-4.2GHz=-25 5-7GHz=-25dB 7-9 GHz=-35 dB	0.7 GHz 0.2 GHz 0.2 GHz	3

 Copyright © 2022. JCT Publications. All Rights Reserved

19	2005	flexible antenna	1-3.5 GHz	2.2-2.4GHz=-13 dB	0.22GHz	1
20	2004	slot antenna	0-8 GHz	1.5-6 GHz=-32.5 dB	4.5 GHz	1

III.MSA based Bow-Tie Antenna

The Microstrip Patch Antennas (MPAs) are used in various fields of applications like fire detection, soil, and water resource and for weather monitoring in the forestry and agriculture applications. They are also used in the vehicle tracking systems by integrating with various wireless network architectures. In recent years, MPAs designs are effectively used in noninvasive diagnosis systems

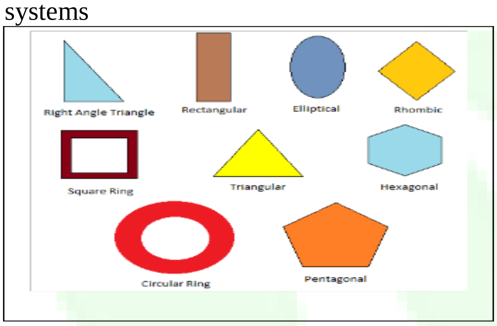


Fig 3.2 Different shapes of micro strip patch.

3.1 Applications of MSA

MSAs are suitable for numerous applications because of their advantages [19, 20]. The telemetry and communications antennas on missiles need to be thin and conformal and are often MSAs. Microstrip radiators are usually used for Radar altimeters but of small arrays
1. In Wireless and Wi-Fi devices.
2. Mobile antenna GSM Application
3. Satellite Communication
4. Outer earth communication

3.2 Coaxial or Probe Feed

The coaxial or probe feed arrangement is shown in Figure 3.3 the center conductor of the coaxial connector is soldered to the patch. Main advantage is that it will be positioned in any location within the patch to match with its input resistivity. It conjointly has the disadvantages i.e. the outlet is to be trained within the substrate and also the instrumentality manufacture outside the lowest ground plane, so it's not fully ground planar. The feeding arrangements make the configuration asymmetrical

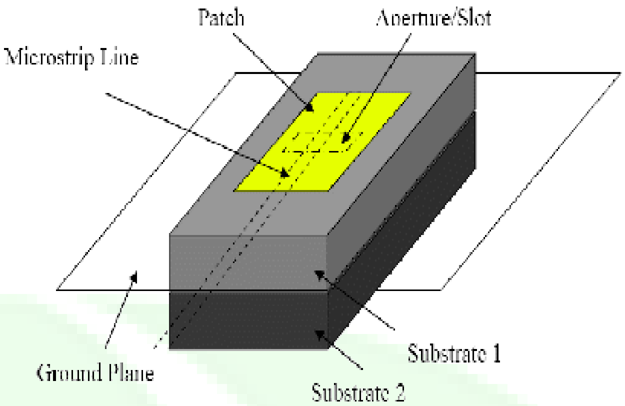


Figure 3.3 Coaxial or probe feed arrangement.

Micro strip Feed Line

A patch excited by micro strip line feed is shown in Figure 3.4. For keeping the total Structure planar this feed can be etched on the same substrate.

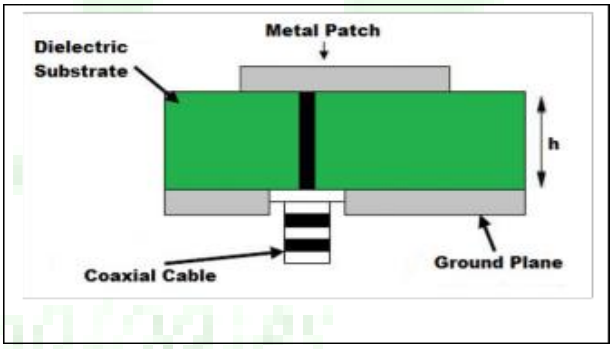


Figure 3.4 Microstrip line feed arrangement.

IV.SIMULATION AND RESULT

In this chapter discuss the simulation and result of the proposed antenna. In this proposed antenna flexible substrate technique as well as multi-layer substrate are used for enhance the bandwidth, return loss (S-11) and other properties of antenna. The proposed multi layer bow tie patch antenna is design for Giga hertz (GHz) frequency range up to 6 GHz. The proposed frequency where this frequency range accommodate in the various band in between 1 GHz to 6 GHz in between the Wi-FI and Wi-Max range.

5.2 CST Design environment

 Copyright © 2022. JCT Publications. All Rights Reserved

The proposed design in the CST 2016 version. The system for designing used is core i-5 4thG processor. The main part of proposed design is substrate (S), patch (P), ground (G) and feeding system (Wave guide feed). In this design using a wave guide wave port for feeding system. In general there are two type of feeding systems first one is wave guide port and second one is the wave guide port.

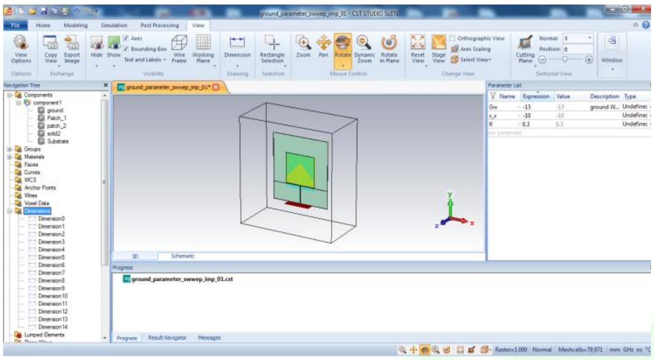


Fig 5.1 (a) Shows the front view of proposed design

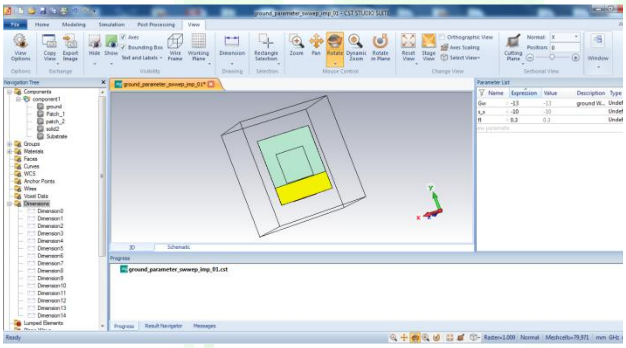


Fig 5.1 (b) Shows the Back view of proposed design (Ground)

Return Loss:

Return loss (S-11) is an important parameter for performance measurement of antenna that is measure is DB. It is the Return loss measure in Db. It is defined as the ratio of output verse input power received by transmitter. The return loss is expressed by –

$$S11(dB) = 10log\frac{P_r}{P_i} \qquad 1$$

Voltage Standing Wave Ratio (VSWR):

The VSWR is also an important parameter for analysis of antenna design. Ideal value of VSWR 1 to 2. For particle system is near to 2. In ideal case VSWR is 1.

$$VSWR = \frac{1+\Gamma}{1-\Gamma} \qquad 2$$

Gain:

Gain is representing as a ratio of radiation intensity in particular direction to total input power transmitted by antenna.

$$\text{Gain (G)} = 4\pi\frac{\text{radiation intensity}}{\text{P total}}$$

$$G_{dBi} = 10.log_{10}(G)$$
$$G_{dBd} = G_{dBi} - 2.5\,dB$$

Where G is denote Gain, is the isotropic gain of antenna. There are the major result parameters. Now discuss the result outcome of proposed method. Also compare the proposed method with different previous methods.

Bandwidth (B.W)[14]

Bandwidth of the antenna is an important parameter for result measurement. In the below equation shows the bandwidth of antenna.

$$B.W. = \frac{f_H - f_L}{f_c} \times 100 \quad f_c = \frac{f_H + f_L}{2}$$

f_H = Higher frequency
f_L = Lower frequency
f_C = Centre off frequency

Number of bands

The total number of bands of any antenna is shows that the working of any antenna in the different rang

Results of Proposed Design

First discuss the result of proposed design 1 the geometry of proposed antenna is discussed already in the previous chapter 4.There are different result parameters are calculate in this flexible proposed multi layer monopole antenna such as bandwidth (B.W.), gain (G), return loss (S-11) and radiation pattern of the antenna.

Return Loss (S -11)

It is the power loss in the signal that is reflected due to discontinuity in the transmission line

V.CONCLUSION

The slotted bow tie patch antenna is resonant at multiple frequencies of 2.4, 3.6, 3.9, 4.9 GHz. Which are unlicensedband and used for wireless applications. So designedantenna can be applied effectively to all wireless applications. But a Micro strip patch antenna having theoperational frequency of 1.8 GHz, 3.8 GHz and 5.2 GHz

VSWR bandwidth and return loss bandwidth up to 23.75db has been obtained shown in figure 3.1. There are the two different S parameters of bow tie antenna and microstrip antenna which are taken through HFSS software.

REFERENCE

 Copyright © 2022. JCT Publications. All Rights Reserved

1. Singh, Saurabh, and Sudhanshu Verma. "Compact wideband circularly polarized bowtie slot antenna for WBAN applications." AEU-International Journal of Electronics and Communications 136 (2021): 153777.

2. Bollavathi, Lokeshwar, Venkatasekhar Dorai, and Sudhakar Alapati. "Wideband planar substrate integrated waveguide cavity-backed amended dumbbell–shaped slot antenna." AEU-International Journal of Electronics and Communications 127 (2020): 153489.

3. Dayo, Zaheer Ahmed, Qunsheng Cao, Permanand Soothar, Mir Muhammad Lodro, and You Li. "A compact coplanar waveguide feed bow-tie slot antenna for WIMAX, C and X band applications." In 2019 IEEE international conference on computational electromagnetics (ICCEM), pp. 1-3. IEEE, 2019.

4. Choudhary, Ekta, Shilpi Sharma, and Pranay Yadav. "A Modified Wideband Bow-Tie Antenna with DGS for Wireless Fidelity Range." In 2018 International Conference on Advanced Computation and Telecommunication (ICACAT), pp. 1-5. IEEE, 2018.

5. Sallam, Mai O., Sara M. Kandil, Vladimir Volski, Guy AE Vandenbosch, and Ezzeldin A. Soliman. "Wideband CPW-fed flexible bow-tie slot antenna for WLAN/WiMax systems." *IEEE Transactions on Antennas and Propagation* 65, no. 8 (2017): 4274-4277.

6. Jilani, S. F., and A. Alomainy. "An inkjet-printed MMW frequency-reconfigurable antenna on a flexible PET substrate for 5G wireless systems." (2017): 13-3.

7. Casula, Giovanni Andrea, Giorgio Montisci, Paolo Maxia, Giuseppe Valente, Alessandro Fanti, and Giuseppe Mazzarella. "A low-cost dual-band CPW-fed printed LPDA for wireless communications." *IEEE Antennas and Wireless Propagation Letters* 15 (2016): 1333-1336.

8. Kumari, Namrata, and Deepak C. Karia. "Design of Apollonian Gasket Bow Tie antenna for satellite application." In *Global Trends in Signal Processing, Information Computing and Communication (ICGTSPICC), 2016 International Conference on*, pp. 291-297. IEEE, 2016.

9. Tang, Ming-Chun, Ting Shi, and Richard W. Ziolkowski. "Flexible efficient quasi-Yagi printed uniplanar antenna." *IEEE Transactions on Antennas and Propagation* 63, no. 12 (2015): 5343-5350.

10. Shao, Shuai, AsiminaKiourti, Robert J. Burkholder, and John L. Volakis. "Broadband textile-based passive UHF RFID tag antenna for elastic material." *IEEE Antennas and Wireless Propagation Letters* 14 (2015): 1385-1388.

11. Naidu, Praveen Vummadisetty, and Akshay Malhotra. "Design & analysis of miniaturized asymmetric coplanar strip fed antenna for multi-band WLAN/WiMAX applications." *Progress In Electromagnetics Research* 57 (2015): 159-171.

12. Tsai, Lin-Chuan. "A triple-band bow-tie-shaped CPW-fed slot antenna for WLAN applications." *Progress In Electromagnetics Research* 47 (2014): 167-171.

13. Naidu, Praveen Vummadisetty, and Raj Kumar. "Design of a compact ACS-fed dual band antenna for Bluetooth/WLAN and Wi-MAX applications." *Progress In Electromagnetics Research*55 (2014): 63-72.

14. Raad, Haider R., Ayman I. Abbosh, Hussain M. Al-Rizzo, and Daniel G. Rucker. "Flexible and compact AMC based antenna for telemedicine applications." *IEEE Transactions on antennas and propagation* 61, no. 2 (2013): 524-531.

15. Khaleel, Haider R., Hussain M. Al-Rizzo, and Ayman I. Abbosh. "Design, fabrication, and testing of flexible antennas." In *Advancement in Microstrip Antennas with Recent Applications*. InTech, 2013.

16. Lin, Chun-Cheng, En-Zo Yu, and Chih-Yu Huang. "Dual-band rhombus slot antenna fed by CPW for WLAN applications." *IEEE Antennas and Wireless Propagation Letters* 11 (2012): 362-364.

17. Yoon, Joong Han, and Young Chul Lee. "Modified bow- tie slot antenna for the 2.4/5.2/5.8 GHz WLAN bands with a rectangular tuning stub." *Microwave and optical technology letters* 53, no. 1 (2011): 126-130.

18. Khaleel, Haider R., Hussain M. Al-Rizzo, Daniel G. Rucker, and Yahiea Al-Naiemy. "Flexible printed monopole antennas for WLAN applications", In *Antennas and Propagation (APSURSI), 2011 IEEE International Symposium on*, pp. 1334-1337. IEEE, 2011.

19. Anagnostou, Dimitris E., Ahmad A. Gheethan, Anthony K. Amert, and Keith W. Whites. "A direct-write printed antenna on paper-based organic substrate for flexible displays and WLAN applications." *Journal of Display Technology* 6, no. 11 (2010): 558-564.

20. Soliman, E. A., W. De Raedt, and G. A. E. Vandenbosch. "Reconfigurable slot antenna for polarization diversity." *Journal of Electromagnetic Waves and Applications* 23, no. 7 (2009): 905-916.

21. Chen, Yan-Lin, Cheng-Li Ruan, and Lin Peng. "A novel ultra-wideband bow-tie slot antenna in wireless communication systems." *Progress In Electromagnetics Research* 1 (2008): 101-108.

22. Wu, Ya-Jie, Bao-Hua Sun, Jian-Feng Li, and Qi-Zhong Liu. "Triple-band omni-directional antenna for WLAN application." *Progress In Electromagnetics Research* 76 (2007): 477-484.

 Copyright © 2022. JCT Publications. All Rights Reserved

ISSN(ONLINE):2278 - 3814

23. Qu, Shi-Wei, and Cheng-Li Ruan. "Effect of round corners on bowtie antennas." *Progress In Electromagnetics Research* 57 (2006): 179-195.
24. Salonen, Pekka, Jaehoon Kim, and YahyaRahmat-Samii. "Dual-band E-shaped patch wearable textile antenna." In *Antennas and propagation society international symposium, 2005 IEEE*, vol. 1, pp. 466-469. IEEE, 2005.
25. Yeo, Junho, Yoonjae Lee, and Raj Mittra. "Wideband slot antennas for wireless communications." *IEE Proceedings-Microwaves, Antennas and Propagation* 151, no. 4 (2004): 351-355.

 Copyright © 2022. JCT Publications. All Rights Reserved