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A Switchable Filtering Antenna Integrated with U-Shaped Resonators for Bluetooth, WLAN & UWB Applications

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ABSTRACT- In this paper, A Switchable Filtering Antenna Integrated With U-Shaped Resonators for Bluetooth, WLAN & UWB Applications is presented. To achieve the UWB operation, a rectangular defect on the ground plane and square slots are etched on the rectangular patch. The selectivity of frequency is achieved by integrating a Hairpin filter. Three switches are connected at the corners of the filter to achieve frequency re-configurability. A total of eight Boolean combinations are possible by controlling ON and OFF these switches. This filtering antenna acts as a band pass filter and picks distinct frequency bands within the UWB frequency. It can be used for wireless applications such as Long-Distance Radio Communication, Aviation Services, WLAN, C-band satellite communication, Wi-MAX, mobile satellite sub-band, radar communications, and space communications. In addition, two inverted U- shaped resonators of differing lengths are engraved on the rectangular microstrip patch to operate at Bluetooth frequency applications with frequencies ranging from 2.4 to 2.458GHz. The maximum gain obtained out of all operating frequencies is 4.82dBi at a frequency of 9.5GHz. The proposed antenna is simulated using the 3D-Simulation tool CST MWS. The performance of the designed antenna is estimated using the parameters like return loss, VSWR, and Far-field Gain characteristics.

General Terms: Boolean combinations, WLAN, Bluetooth, UWB Applications.
Keywords: DGS (Defected Ground Structure), Filtering Antenna, Resonator, Hairpin filter.

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1. INTRODUCTION

Since the FCC opened up the 3.1–10.6 GHz spectrum for ultra-wideband (UWB) operation, several protocols have been developed to provide moderate and high-rate short-range communication systems. To fulfill commercial and functional standards, various systems such as wireless-broadband (WiBro), wireless local area network (WLAN), and wireless personal area network (WPAN), must include a compact and portable wideband or multiband antenna [1]. One of the most essential aspects of UWB is that it is a zero-carrier technology, which means that no carrier is required for pulse transmission. This gives insight into future development. Because of its low cost, fast data rate, and superior multipath and jamming resistance, UWB systems have piqued the interest of academics all around the world. [2] discussed about a system, a low power area reduced and speed improved serial type daisy chain memory register also known as shift Register is proposed by using modified clock generator circuit and SSASPL (Static differential Sense Amplifier based Shared Pulsed Latch). This latch based shift register consumes low area and low power than other latches. There is a modified complementary pass logic based 4 bit clock pulse generator with low power and low area is proposed that generates small clock pulses with small pulse width. The vast frequency range for UWB systems between 3.1–10.6 GHz will cause interference with current wireless communication systems, such as IEEE 802.11a WLANs running in the 5.15–5.35 and 5.725–5.825 GHz bands, necessitating the deployment of a UWB antenna with band selective capability [3]. Microstrip patch antennas (MPAs) are gaining popularity in current research due to their smaller patch size, increased bandwidth, and suppression of unwanted cross-polarized radiations. The Defected Ground Structure (DGS) is essential for improving the traditional MPA's features. Based on the shape and size of the ground defect, the DGS introduces a form defect on the ground plane that disrupts shielded dispersion. This has an impact on the antenna's input impedance and current flow [5]. Recently, microwave filters gained a lot of popularity to achieve frequency selective characteristics. A filter is a 2-port network that transmits at frequencies within the filter's pass band and attenuates in the filter's stop band to regulate the frequency response at a given location in a system.

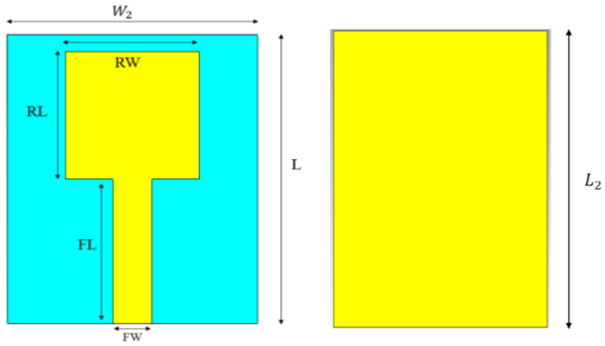
In all communication systems, microstrip band pass filters play a significant role. Microstrip circuits provide benefits over other microwave transmissions such as waveguides, coaxial cables, and strip lines as filters that are realized with wide bandwidth, compact size, easy fabrication, and high reliability and reproducibility. These filters built on printed circuit boards (PCB) have the advantage of being simple and inexpensive to mass-produce in various dielectric constants [6-8]. A filter is a 2-port network that transmits at frequencies within the filter's pass band and attenuates in the filter's stop band to regulate the frequency response at a particular location in a system [9-11]. A microstrip bandwidth reconfigurable filtering antenna may be created by simply tuning the transmitting zeroes. With transmission zeros, an electrically reconfigured BPF was achieved, resulting in substantially greater selectivity. The conformal profile, compact size, [4] emphasized that people who are visually impaired have a hard time navigating their surroundings, recognizing objects, and avoiding hazards on their own since they do not know what is going on in their immediate surroundings. We have devised a new method of delivering assistance to people who are blind in their quest to improve their vision. An affordable, compact, and easy-to-use Raspberry Pi 3 Model B+ was chosen to demonstrate how the proposed prototype works and simple structure of this antenna are all benefits [12-14]. Carving a slit in the radiating patch or introducing a degenerate structure near the feeding line or ground plane is commonly used to provide the notch function.

To achieve re-configurability, two microstrip lines parallel to the feeding line and two PIN diodes are employed [16-17]. The use of lumped components such as positive-intrinsic-negative (PIN) diodes allows antennas with reconfigurable structures to be modified, allowing them to adapt to varied frequencies [18-19]. To adjust the resonance frequency, patch antenna slots are provided, and these slots are linked or detached using switches [20]. Because of their use in integrated circuits and applications, switchable antennas are highly recommended [21]. By introducing two transmission zeros through two independent U-shaped resonators integrated at the rectangular patch, the bandwidth reconfigurable filtering antenna is illustrated in [22-23]. The transmission zeroes are generated when the resonators are linked to the antenna's transmission line over a minimum coupling distance [24]. But these filtering antennas offer tore complexity while integrating with the filter structure. Additionally, the tuning of operating frequency is also difficult in the above literature.

In this paper, a simple UWB Microstrip Antenna is proposed and integrated with a hairpin filter on a defected ground structure (DGS) with a microstrip feed line. The selectivity of frequency is implemented by installing three switches at the corners of the filter. Further, two resonators are introduced to extend the band of operation to Bluetooth applications.

2. ANTENNA DESIGN

The suggested antenna is made of FR4 and has a dielectric constant of 4.4, with a loss tangent of 0.002. Between the ground plane and a rectangular patch of 32*16mm^2size, the substrate is sandwiched. The overall dimension of the proposed design is 34*30*1.6 mm^3 . The antenna is fed with a conventional microstrip line feed with a dimension of 17*4.7mm^2. The geometry of the basic design is shown in *figure 1*. In the *table1*, the dimensions of the proposed design are listed.



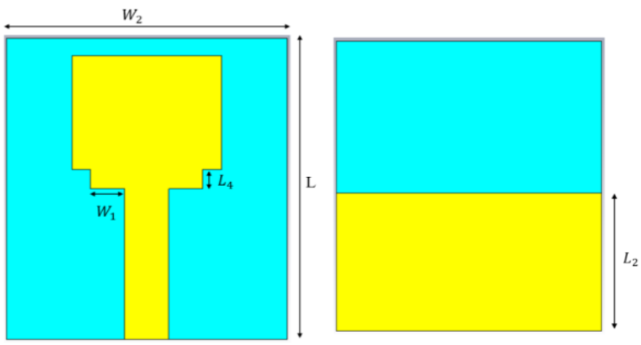
(a)Aerial view (b) Back view

Figure 1: Proposed Basic Design

Table 1: Dimensions of the proposed Basic Design

S. No	Parameter	Value(mm)
1	RL	15
2	RW	16
3	W2	30
4	L2 (full ground)	34
5	L2(partial ground)	16.2
6	FL	17
7	FW	4.7
8	L	34

The proposed antenna is implemented with the defected ground structure to enhance the bandwidth. The dimension of the ground plane is optimized to 16.2*30mm^2. Furthermore, two rectangular slots with the size of 2*2.2mm^2 are carved onto the rectangular patch. *Figure 2* depicts the proposed design with a defected ground structure and with two rectangular slots.



(a)Defected ground structure (b) Rectangular slot

Figure 2: Proposed Design with DGS

In recent times, microwave filters have gained much attention to achieve frequency re-configurability. Microwave filters improve the signal-to-noise ratio by removing undesired frequency components from the stream. These filters are especially effective in the radio UHF region, where they may filter out unwanted broadcasts and improve the receiver's relative sensitivity.

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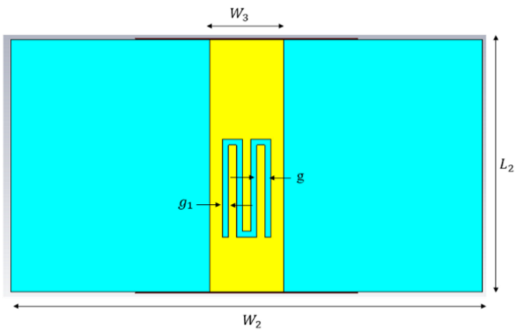

Figure 3: Hairpin filter

A hairpin filter is chosen because grounding is not necessary. The hairpin filter is designed to operate at (2.478-12.613) GHz. This design is shown in *figure 3*. The filter dimensions are tabulated in *table 2*.

Table 2: Dimensions of the Hairpin Filter

S. No	Parameter	Value
1	L1	6.6
2	G	0.5
3	G1	0.4
4	L3	3.7
5	W3	4.7

Table 3: Boolean combinations along with switch conditions

Combinations	SW1	SW2	SW3
000	OFF	OFF	OFF
001	OFF	OFF	ON
010	OFF	ON	OFF
011	OFF	ON	ON
100	ON	OFF	OFF
101	ON	OFF	ON
110	ON	ON	OFF
111	ON	ON	ON

To achieve frequency re-configurability without increasing the size of the antenna, the hairpin filter is integrated within the feed line. After integrating with the hairpin filter, the antenna is considered a filtering antenna which is portrayed in *figure 4*.

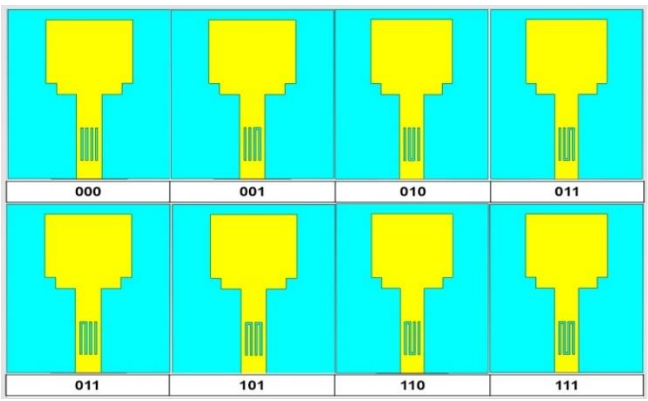

Figure 4: Eight possible switching combinations

The proposed filtering antenna with eight combinations of switches is used to select the frequencies within the UWB frequency range. In addition to the UWB frequency, two inverted-shaped resonators are etched on the patch to operate at Bluetooth frequency (2.4GHz to 2.458) GHz. The filtering antenna along with the resonators is shown in *figure 5*. The optimized dimensions of the resonators are tabulated in *table 4*. For better visualization of the resonator part, it is enlarged and depicted.

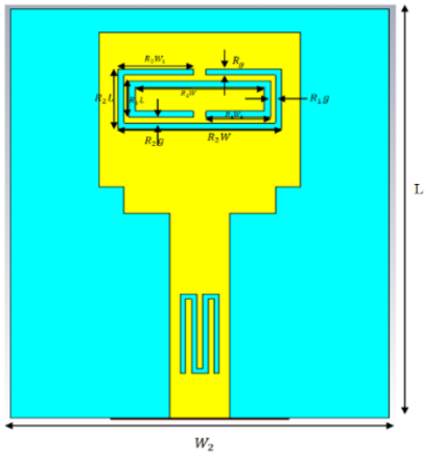

Figure 5: Filtering antenna along with the resonators

To reconfigure the operating frequency of the filtering antenna, three switches are considered at the bending corners of the hairpin filter. To be used as an ON switch, the metallization is present at the corners, and to act as an OFF switch, the metallization is removed. Because of these three switches, eight Boolean switching combinations are possible. The antenna is analyzed at these eight switching conditions. The possible eight combinations are shown in *figure 5*. The Boolean combinations along with the switch conditions are mentioned in *table 3*.

Table 4: Dimensions of the resonators

S. No	Parameter	Value (mm)
1	R1L	3
2	R2L	5
3	R1W	10.2
4	R2W	13
5	R1G	0.4
6	RG	0.5
7	R2G	0.5
8	R1W1	5.1
9	R2W1	6

3. RESULTS AND DISCUSSION

The designed antenna is simulated using the CST MWS 3D-simulation tool. Initially, the rectangular-shaped patch antenna is simulated and analyzed. The antenna is operated at 9.24GHz with a return loss of -24.90dB. The bandwidth obtained is very small, *i.e.*, 288.8MHz. The gain obtained at this operating frequency is 4.9 dB, as shown in *figure 6*. The return loss plot of the proposed design is shown in *figure 7*.

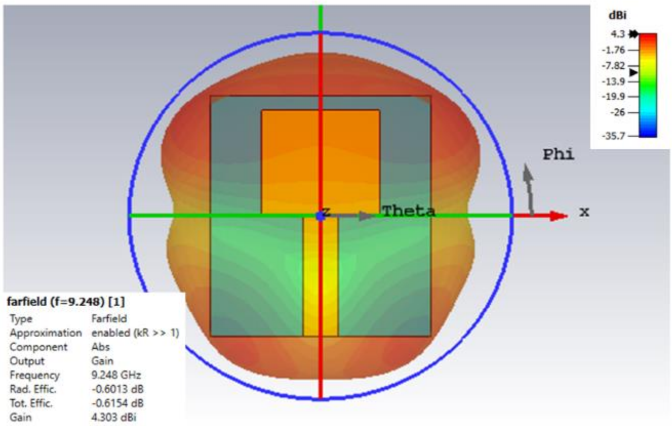

Figure 6: Plot showing the gain

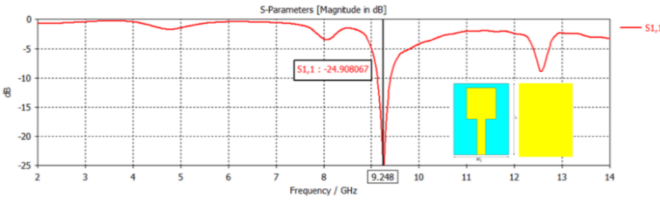

Figure 7: Plot showing the obtained return loss

The proposed antenna ground plane is carved to disrupt the passage of current in the metal plane to boost bandwidth. The rectangular-shaped part is removed from the ground plane using the Defected Ground Structure (DGS). After optimizing the ground plane, the operating bandwidth was increased from 2.95GHz to 7.75GHz. The bandwidth obtained is 4.79GHz.

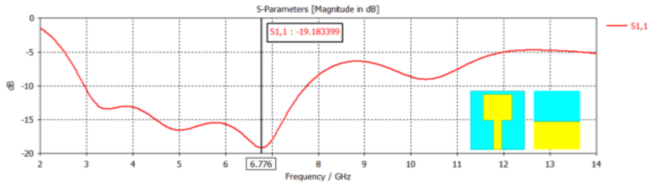

Figure 8: Return Loss plot

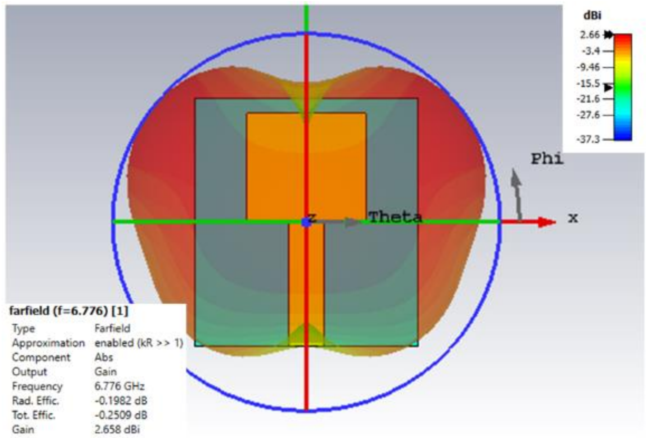

Figure 9: Gain plot of the proposed design

This operating frequency range covers electromagnetic bands like S-Band and C-Band. Wi-MAX (2.3-2.4, 2.5-2.7, 3.4-3.6GHz), WLAN (2.4, 3.64, 0.9, & 6GHz), and Long-Distance Radio Communication (3.5 & 7GHz) applications all employ this configuration. The minimum loss is 19.183dB at a frequency of 6.77GHz. The gain at this frequency is 2.856dB. The return loss plot and gain plots are displayed in *figures 8* & *9*.

Further, two square shapes are etched on the bottom side in opposite directions of the rectangular patch to increase the bandwidth. This configuration operates from a frequency of 2.88 to 8.412 GHz. The bandwidth achieved is 5.53 GHz. This leads to an increase in the bandwidth from 4.79GHz to 5.53GHz, *i.e.*, 736MHz. The minimum return loss obtained is-19.23 at 7.44GHz and the gain is 3.35dB at this frequency. The return loss and gain plots are depicted in *figures 10 and 11*.

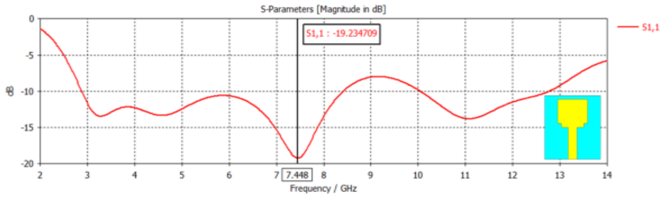

Figure 10: Return loss plot of the proposed design

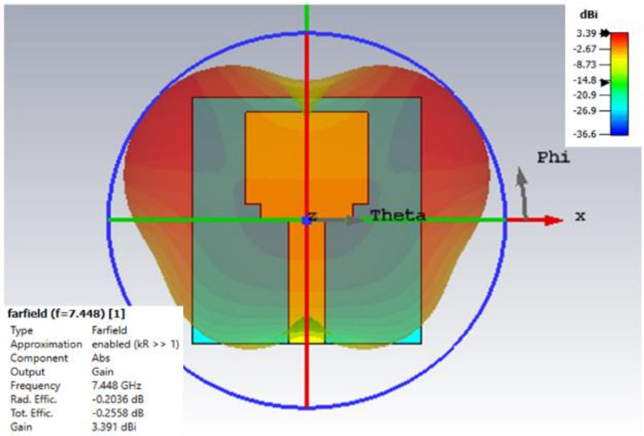

Figure 11: Gain plot of the proposed design

To confer the frequency re-configurability, the filter is integrated with the feed line. Due to the integration of the hairpin filter, the proposed design selects the pass band frequencies for the required wireless applications. Three switches are substituted for eight Boolean possibilities using a third-order filter. Because of their dependability, low cost, high switching speed, compact size, and lower capacitance and resistance in their ON and OFF states, pin diodes will be employed for the reconfiguration. The 8 combinations of the filter are explained, starting from all switches OFF to all switches ON.

3.1 Case-1{All switches OFF (000)}

For each 000 combination, the graph represents the simulated S_{11}. In this case, all of the switches are turned off, allowing

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electricity to flow via the shortest distance and radiate from every section of the antenna. The antenna has two frequency bands: (2.87-8.42) GHz and (9.95-12.61) GHz. The radiation pattern of these bands is nearly identical to that of the remainder of their frequency range. The frequency range (8.42–9.95) GHz is rejected from the total UWB frequency by this combination. At 7.42GHz, this combination produces a minimum return loss of 19.19dB. *Figure 12* shows the return-loss graphs for the first four combinations. This antenna is suitable for wireless applications such as Wi-MAX, WLAN, and long-range radio communications. This combination produces radiation that is nearly constant. *Figure 13* depicts the radiation patterns of the first four circumstances.

3.2 Case-2 {Two switches OFF and third switch ON (001)}

The graph depicts the S_{11} simulation for the 001 combination. The first two switches are turned OFF, while the third switch is turned ON. The antenna resonates in three frequency bands: (2.87-5.31) GHz, (6.96-8.68) GHz, and (9.92-12.61) GHz. The frequency bands of (5.32-6.96) GHz and (8.68-9.92) GHz are rejected from the whole UWB frequency by this combination. At 7.4GHz, this circumstance results in a minimum return loss of -24.12dB. This antenna is suitable for wireless applications such as aviation and radiolocation. With a maximum gain of 3.43dB at 7.4GHz, this case delivers almost steady radiation patterns over the full operating frequency ranges.

3.3 Case-3 {first and third switches OFF and second switch ON (010)}

The S_{11} simulation for the 010 combination is shown in the graph. The first and third switches are OFF, and the second switch is ON. This combination serves as a notch-filter for the frequency band (5.84-6.68) GHz, with a bandwidth of 840MHz. This situation leads to a minimal return loss of -51.03dB at 6.512GHz. This antenna is ideal for wireless communications, such as long-distance radio conversations. This combination produces consistent radiation patterns throughout the entire working frequency range, with a maximum gain of 2.76dB at 6.51GHz.

3.4 Case-4 {first switch OFF and two and three switches ON (011)}

The simulated S_{11} for the 011 combination is shown in the graph. The first switch is turned OFF in this scenario, but the second and third switches are turned ON. The antenna has a fixed frequency range of (5.41-7.82) GHz. This situation produces a minimum return loss of -50.82dB at 5.61GHz.

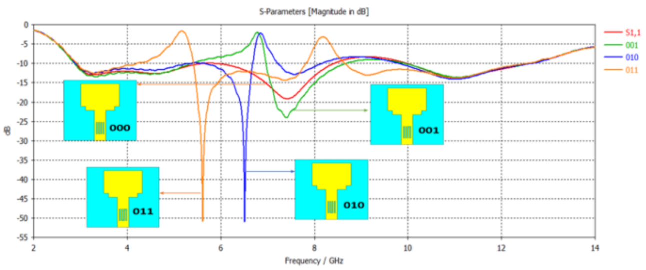

Figure 12: Return loss plots of the first four switch combinations

This antenna is appropriate for WLAN and other wireless applications. This case produces virtually constant radiation patterns throughout the entire working frequency range, with a maximum gain of 2.67dB at 5.61GHz.

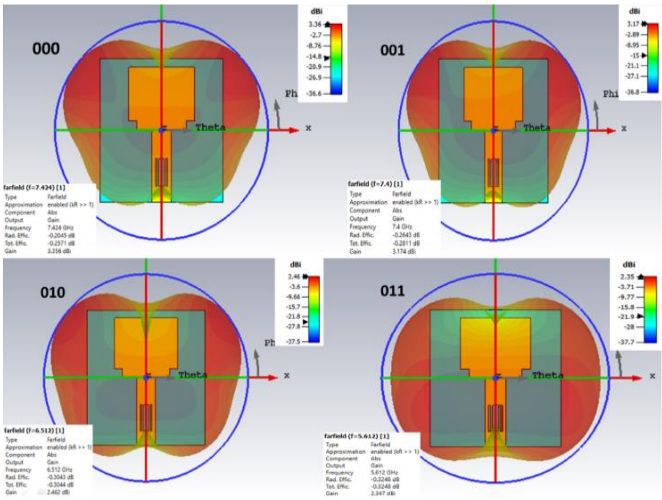

Figure 13: Radiation patterns of the first four combinations

3.5 Case-5 {first switch ON and two and three switches OFF (100)}

The S_{11} for 100 combination simulation is depicted in the graph. In this setup, the first two switches are turned OFF and the third switch is turned ON. The antenna operates in a single frequency band of 6.9681 to 8.681 GHz. This situation leads to a minimal return loss of -24.12dB at 7.4GHz. This antenna is ideal for wireless applications, especially satellite communications and Wi-MAX applications. This case produces consistent radiation patterns throughout the entire working frequency range, with a maximum gain of 3.43dB at 7.4GHz.

3.6 Case-6 {second switch OFF and first and third switches ON (101)}

The graph depicts the S_{11} simulation for the 101 combinations. The first two switches are turned OFF, while the third switch is turned ON in this scenario. The antenna has a single frequency band that ranges from 6.96 to 8.68 GHz. At 7.4GHz, this circumstance results in a minimum return loss of -24.12dB. This antenna is an excellent choice for wireless applications, particularly satellite communications and Wi-MAX applications. With a maximum gain of 3.43dB at 7.4GHz, this case delivers steady radiation patterns over the full operating frequency ranges.

3.7 Case-7 {first and second switches ON and the third switch OFF (110)}

The graph depicts the S_{11} for 110 combinations as simulated. The first and second switches are both turned ON, whereas the third switch is turned OFF in this configuration. The antenna has a single frequency band that ranges from (5.41-7.82) GHz. At 5.61GHz, this circumstance results in a minimum return loss of -50.81dB. This antenna is suitable for wireless applications such as WLAN. With a maximum gain of 2.67dB at 5.61GHz, this case delivers steady radiation patterns over the full operating frequency ranges.

3.8 Case-8 {All switches are ON (110)}

The graph depicts the S_{11} simulation for the 111 combinations. All the switches are switched on in this circumstance, allowing energy to go the greatest distance and radiate from every part of the antenna. The antenna may resonate in two different frequency bands: (4.79-7.98) GHz and (9.28-12.56) GHz. The frequency range (7.98-9.28) GHz is rejected from the whole UWB frequency by this combination. This combination yields a minimal return loss of -28.22dB at 9.52GHz. This antenna is perfect for mobile satellite sub-band communications as well as satellite or radar communications. This combination produces essentially constant radiation patterns throughout the full working frequency ranges, with a maximum gain of 5.05dB at 9.524GHz. *Figures 14* and *15* shows the return loss graphs and radiation patterns for the last four combinations. The return loss, gain, and applications of the eight switch combinations are given in *table-5*.

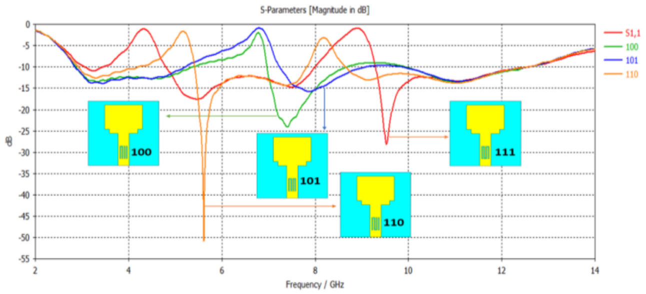

Figure 14: Return loss plots of the last four combinations

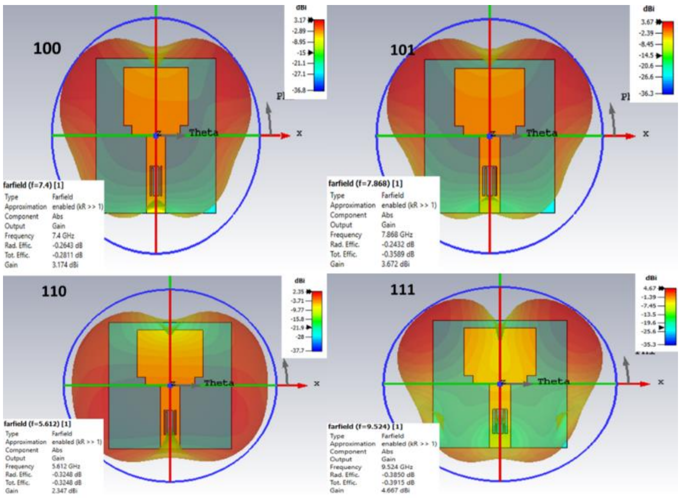

Figure 15: Radiation pattern of the last four combinations

3.9 RESONATOR

The proposed antenna now covers many wireless applications from 3GHz to 12GHz frequency bands like Wi-MAX, WLAN, Long-Distance Radio Communication, Aviation Services, Radiolocation Services, mobile satellite sub-band, and satellite or radar communications.

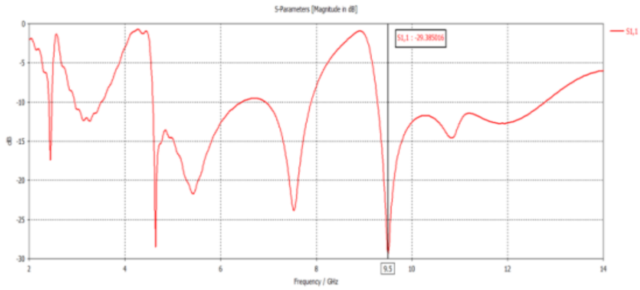

Figure 16: Minimum return loss plot of the resonator

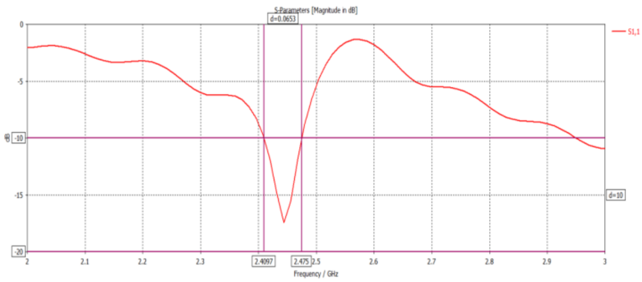

Figure 17: Minimum return loss plot of the resonator (Bluetooth Applications)

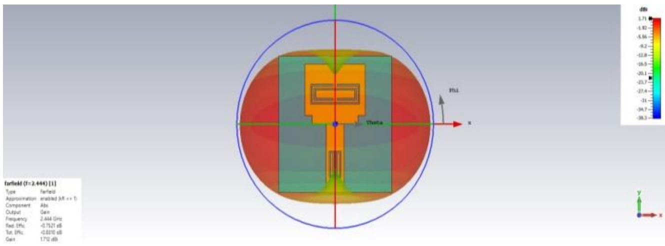

Figure 18: Gain plot of the resonator at Bluetooth Applications

But it does not cover the Bluetooth frequency band, i.e., (2.4-2.458) GHz. To cover the Bluetooth frequency also, the proposed design is integrated with two inverted U-shaped resonators, which are etched on the rectangular patch. The lengths of the resonators are optimized to operate at Bluetooth frequencies. In each resonator, there is destructive interference of the signal. As a result, the filter's insertion loss response has a transmission zero. The final design will operate at a frequency range of 2.4097 to 2.475GHz along with a 9.5GHz pass band frequency. The minimum return loss obtained is -29.38dB and the gain is 1.71dBi at a particular frequency of 9.5GHz.

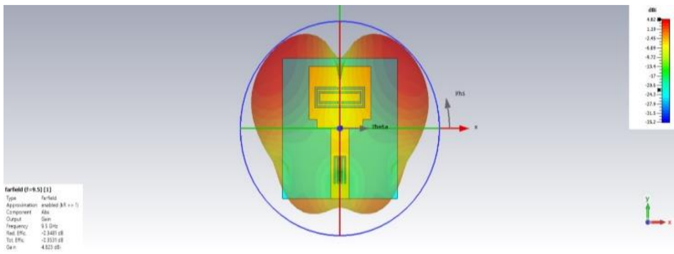

Figure 19: Gain plot of the resonator at Radar Applications

4. CONCLUSION

A Switchable Filtering Antenna Integrated with U-Shaped Resonators for Bluetooth, WLAN & UWB Applications is designed and simulated. The basic design with a rectangular patch operates at a frequency of 9.24GHz. The ground length is reduced to make it a defected ground structure (DGS) to improvise the bandwidth. The suggested antenna is investigated and optimized in several reconfigurable circumstances before being tested. The bandwidth of the filtering antenna is increased from (8.42 to 9.52) GHz, which covers the mobile satellite sub-band and satellite or radar communication applications. The Bluetooth band is integrated within a UWB antenna using two resonators engraved on the microstrip patch. At this stage, the necessary bandwidth, i.e., (2.4-2.45) GHz for Bluetooth applications is achieved. The return loss is less than -10dB for all operational frequencies and all switching combinations of the hairpin filter, including the resonators, exhibit sustainable radiation patterns. Out of these, the maximum gain was achieved, i.e., 4.82dBi after integrating the resonators on the rectangular patch.

5. FUTURE WORK

The proposed design is compact and a simple rectangular patch is used as a radiating element. The proposed design is operating at different microwave frequencies with very good gain values. The feed line width is more i.e., $W/_h >> \lambda$ causes unnecessary radiation. It leads to fringing effects and surfaces current. The Feed line width may be reduced further to increase the performance of the proposed design. The Design may be fabricated to verify the performance.

Table 5: Switch Combinations of Respective Filter

S. No.	Switch Combinations	Operating Frequencies (GHz)	Minimum Return Loss	Gain(dBi)	Applications
1	000	2.87-8.42 & 9.95-12.61	-19.19 at 7.42GHz	3.35	Wi-MAX, WLAN, and Long-Distance Radio Communication
2	001	2.87-5.31, 6.96-8.68 & 9.92-12.61	-24.12 at 7.4GHz	3.17	Aviation services and Radiolocation Services
3	010	6.51	-51.03 at 6.51GHz	2.46	Long-distance radio telecommunications
4	011	5.41-7.82	-50.82 at 5.61GHz	2.34	WLAN
5	100	6.96-8.68	-24.12 at 7.4GHz	3.17	Satellite communication and Wi-MAX Applications
6	101	7.23-9.09	-15.80 at 7.86GHz	3.67	Satellite and space communications
7	110	5.41-7.82	-50.81at 5.61GHz	2.34	WLAN
8	111	4.79-7.98 & 9.28-12.56	-28.22 at 9.52GHz	4.66	Mobile satellite sub-band and satellite or Radar Communications

Table 6: Summary of Design stages of designed Antenna

S. No	Type of Design	Operating frequencies (GHz)	Minimum Return loss	Gain (dBi)	Applications
1.	Basic Design	9.24	-24.90 at 9.24GHz	4.30	mobile satellite sub-band and satellite or Radar Communications
2.	Defected Ground Structure	2.95-7.75	-19.18 at 6.77GHz	2.65	mobile satellite sub-band and satellite or Radar Communications
3.	Rectangular plots	2.88-8.41	-19.23 at 7.44GHz	3.39	
4.	Filter	4.79-7.99 & 9.29-12.61	-28.22 at 9.52GHz	4.66	
5.	Resonator	2.40-2.47	-17.44 at 2.44GHz	1.71	Bluetooth
		9.5	-29.38 at 9.5GHz	4.82	Radar Communications

REFERENCES

[1] Sheng Tu, Yong-Chang Jiao, Zheng Zhang, Yue Song, and Shun-Man Ning, "Small Internal 2.4-GHz/UWB Antenna for Wireless Dongle Applications", IEEE Antennas and Wireless Propagation Letters, Vol. 9, pp.284 - 287, 2010.

[2] Wen Tao Li, Yong Qiang Hei, Wei Feng, and Xiao Wei Shi, "Planar Antenna for 3G/Bluetooth/WiMAX and UWB Applications With Dual Band-Notched Characteristics", IEEE Antennas And Wireless Propagation Letters, Vol. 11, 2012, p.p: 61-64.

[3] Valizade, Ch. Ghobadi, J. Nourinia, M. Ojaroudi, "A Novel Design of Reconfigurable Slot Antenna with Switchable Band Notch and Multi

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resonance Functions for UWB Applications", IEEE Antennas and Wireless Propagation Letters, Vol. 11, 2012

[4] Nasrin Tasouji, Javad Nourini, Changiz Ghobadi, Farzad Tofigh, "A Novel Printed UWB Slot Antenna With Reconfigurable Band-Notch Characteristics", Ieee Antennas And Wireless Propagation Letters, Vol.12, 2013, p.p: 922-925.

[5] Mohammad Ojaroudi , Noradin Ghadimi, "Reconfigurable Band-Notched Small Square Slot Antenna With Enhanced Bandwidth For Octave-Band, Multi resonance Applications", Microwave and Optical Technology Letters , Vol. 56, No. 8, August 2014, p.p; 1960-1965.

[6] M Kumar Khandelwal, B Kumar Kanaujia, S Dwari, S Kumar, A.K. Gautam, "Analysis and design of dual-band compact stacked Microstrip patch antenna with the defected ground structure for WLAN/Wi-Max applications", Vol. 69, pp. 39-47, January 2015.

[7] Amanpreet Kaur, "Semi Spiral G-shaped dual wideband Microstrip Antenna with Aperture feeding for WLAN/WiMAX/U-NII band applications ", International Journal of Microwave and Wireless Technologies, page 1 of 11. Cambridge University Press and the European Microwave Association, 2015.

[8] Amanpreet kaur , Rajesh Khanna, Machavaram Kartikeyan, "A multilayer dual wideband circularly polarized microstrip antenna with DGS for WLAN/Bluetooth/ZigBee/Wi-Max/ IMT band applications", International Journal of Microwave and Wireless Technologies, page 1 of 9. Cambridge University Press and the European Microwave Association, 2015.

[9] M Sontakke, V Savairam, S Masram, P.P. Gundewar, "Microstrip Patch Antenna with DGS for Bluetooth Application", International Journal of Engineering Research & Technology (IJERT) Vol. 6 Issue 03, March-2017.

[10] S. A. Vijaya Lakshmi, P. Muthukumaran, "Design and Implementation of Hairpin Bandpass Filter Using Defected Microstrip Structures (DMS)", International Journal of Future Innovative Science and Engineering Research (IJFISER), Vol.2, Issue-1, pp- 251, March 2016.

[11] Yuan, Z.; Chang-Ying, "An approach for optimizing the reconfigurable antenna and improving its reconfigurability", In Proceedings of the IEEE International Conference on Signal Processing, Communications, and Computing (ICSPCC), Hong Kong, China, pp. 1–5, 8th August 2016.

[12] Zhengpeng Wang, Peter S. Hall, James R. Kelly, Peter Gardner, "Wideband Frequency-Domain and Space-Domain Pattern Reconfigurable Circular Antenna Array", IEEE Transactions On Antennas And Propagation, Vol. 65, No. 10, p.p: 5179-5189, October 2017.

[13] Dhanade, Y. B, Choukiker, Y. K, "Frequency and polarization reconfigurable antenna for wireless communication", International Conference of Electronics, Communication and Aerospace Technology, ICECA 18 December 2017, p.p: 287-290.

[14] Hong-wei Deng, Tao Xu and Fei Liu, "Broadband Pattern-Reconfigurable Filtering Microstrip Antenna with Quasi-Yagi Structure", IEEE Antennas and Wireless Propagation Letters, Vol. 17, pp. 1127-1131, July 2018.

[15] H. Yang, Xiaoli Xi, Lili Wang, Yuchen Zhao, Xiaomin Shi, and Yanning Yuan, "Design of reconfigurable filtering ultra-wideband antenna with switchable band-notched functions", International Journal of Microwave and Wireless Technologies, volume 11, pp. 368 – 375, May 2019.

[16] Zhengpeng Wang, Peter S. Hall, James R. Kelly, Peter Gardner, "Wideband Frequency-Domain and Space-Domain Pattern Reconfigurable Circular Antenna Array", IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 65, NO. 10, p.p: 5179-5189, OCTOBER 2017.

[17] Dhanade, Y. B, Choukiker, Y. K, "Frequency and polarization reconfigurable antenna for wireless communication", International Conference of Electronics, Communication and Aerospace Technology, ICECA 18 December 2017, p.p: 287-290.

[18] Mustafa M. Al-Saeedi, Ahmed A. Hashim, Omer H. Al-Bayati, Ali Salim Rasheed, Rasool Hasan Finjan, "Design of dual-band slotted reconfigurable antenna using electronic switching circuit", Indonesian Journal of Electrical Engineering and Computer Science Vol. 24, No, pp 386-393, 1 October 2021.

[19] M N. Pawar, D V. Niture, Dr. S. P. Mahajan, "Design and Implementation of Frequency Reconfigurable Antenna for Wireless Applications", Wireless Communication Technologies in 5G and 6G, 29 April 2021.

[20] B. R. Sanjeeva Reddy, Naresh K. Darimireddy, Chan-Wang Park and Abdellah Chehri, "Performance of Reconfigurable Antenna Fabricated on Flexible and Nonflexible Materials for Band Switching Applications", 29 April 2021s.

[21] Deepa T, Safrine k, Malathi. K, GulamNabi Alsath, P. Sambandham, Sridhar Bilvam, Sandeep Kumar Palaniswamy, Rama Rao Tippuraj, "Bandwidth Reconfigurable Filtering Antenna", Wireless Personal Communications, Springer, 13th February 2019.

[22] Brij K. Bharti, Abhay K. Singh, Raksh P. S. Gangwar, and Reeta Verma, "Frequency and Time Domain Analysis of Triple Band Notched UWB Antenna with Integrated Bluetooth Band", Progress in Electromagnetics Research, Vol. 105, pp. 109–118, 2021.