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Gain Improvement of CPW feed UWB Antenna for Personal Wireless Communication Applications

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Abstract: - In this paper a slotted CPW fed Ultra wide-band antenna operating over the frequency range of to GHz for personal wireless short range communication applications is designed and investigated. The proposed antenna consists of radiating patch, ground plane and CPW feed-line with radial slot in the centre of the radiating patch. The antenna is fabricated on a FR-4 glass epoxy substrate of 1.6mm thickness having loss tangent of 0.02 and dielectric constant of ξr = 4.4 and is investigated using HFSS EM simulation software. The proposed antenna has a compact dimension of 24×20 mm^2. The antenna has measured VSWR ≤ 2 over the frequency range 3 - 10.8 GHz and exhibits good electrical characteristics in both frequency and time domain. Furthermore, different gain improvement techniques for CPW fed UWB antenna are investigated.

Keywords: - *CPW fed, Ultra wideband antenna, gain improvement, stacked antenna.*

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I. INTRODUCTION

Wireless devices are becoming increasingly popular in commercial applications. The pitfall in wiring devices has encouraged researchers to implement solutions for wireless communication. Every wireless communication system consists of antenna that transmits and receives the signal to/from source/destination making antennas integral part of such systems. These antennas embedded in these handheld devices/ devices mounted on body must have specification such as light weight, compact structure, low profile, robustness and conform-ability and are expected to grab as much spectrum as possible to provide multi-band or broadband operation [1]-[4]. Several technologies such as 2.4GHz Bluetooth IEEE 802.11 b/g (2.4–2.484GHz), 3.5GHz WiMAX IEEE 802.16 (3.4–3.6GHz), 5.2/5.8GHz WLAN IEEE 802.11 a (5.15–5.35GHz and 5.725–5.825GHz) and 5.5GHz HIPERLAN2 (5.47–5.725GHz) have been popularly used for implementing various wireless applications[4]-[5]. Ultra wide-band (UWB) is an another popular growing technology choice amongst researchers due to its exceptionally large bandwidth of 7.5 GHz operating over 3.1 to 10.6 GHz frequency band[6]. Several researchers have presented different antenna structures for UWB applications. Popularly used feeding mechanisms for these antenna reportedly in [4]-[8] are microstrip feedline, CPW feedline, ACS feedline and proximity feedline. In this paper, a CPW fed UWB antenna with slotted structure in the radiating patch for UWB applications have been investigated. Gain is an important parameter that defines antenna outreach. Hence, different gain enhancement techniques for CPW fed UWB antenna have been proposed and investigated in this paper.

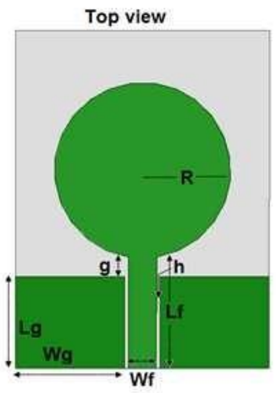
II. ANTENNA DESIGN

The proposed antenna is an extension of work proposed in [11] (as shown in Fig. 1). The proposed antenna (as shown in Fig. 2) consists of a circular radiating patch with a radial slot in the centre of the radiating patch. The antenna is fed with CPW feed line with ground plane on the same side as that of radiating patch making integration of antenna easier with other integrated circuits.The radius of the circular radiating patch is calculated using equation 1 following [12]-[13]:

$$a = \frac{F}{\left\{1 + \frac{2h}{\pi \varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h}\right) + 1.7726\right]\right\}^{1/2}} \quad ..(1)$$

And $F = \dfrac{8.791\times10^{9}}{f_r\sqrt{\varepsilon_r}}$ …(2) Where h = thickness of substrate in cm, ε_r is the dielectric constant of the material.

The theoretical dimensions of the radiating patch frequency 3.1 GHz is 6.1mm mm while the optimized dimensions of the slotted CPW feed UWB antenna are as follows: R(radius of radiating patch) = 6.25mm, Rib (Radius of slot) = 3.25mm, Lsub (length of substrate) = 24 mm, Wsub (width of substrate) = 20 mm, Wf (width of feed line) = 2 mm, Lf (Length of feed line) = 10mm, Lg (length of ground plane) = 8.75mm, Wg (width of ground plane) = 9.75mm, gap between radiating patch and ground plane g = 1.25mm, gap between CPW feed line and ground plane h = 0.25mm.



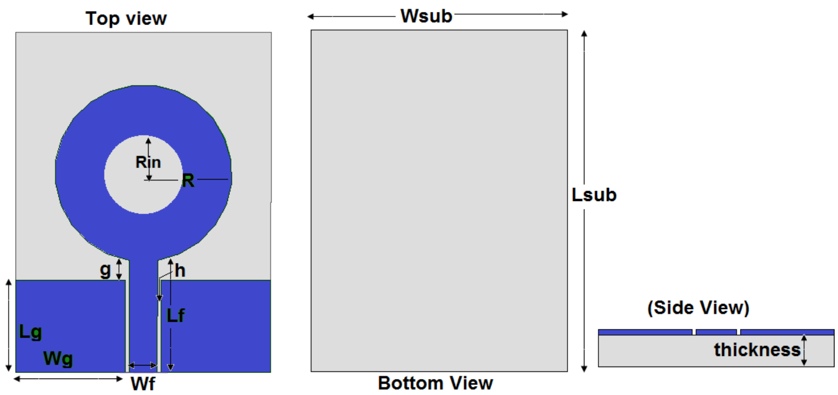


Fig. 1 Antenna proposed in literature[11] (Antenna-1).

Fig. 2 Proposed slotted CPW UWB antenna (Antenna -2)

Based on the concepts of Theory of Characteristics Modes (TCM) proposed in [5] and [14], a circular radiating patch antenna can exhibit different modes. The closed loop current on the radiating patch doesn't contribute towards constructive radiation, more ever, these closed loop currents offer destructive radiations thereby decreasing the radiation efficiency and gain of the antenna. Hence, minimizing the closed loop currents can maximize the radiation behaviour of the antenna. Fig. 4 shows comparative VSWR variation of the proposed Antenna-2 with Antenna-1. As evident from Fig. 4, Antenna-2 offers more bandwidth as compared to the Antenna-1.

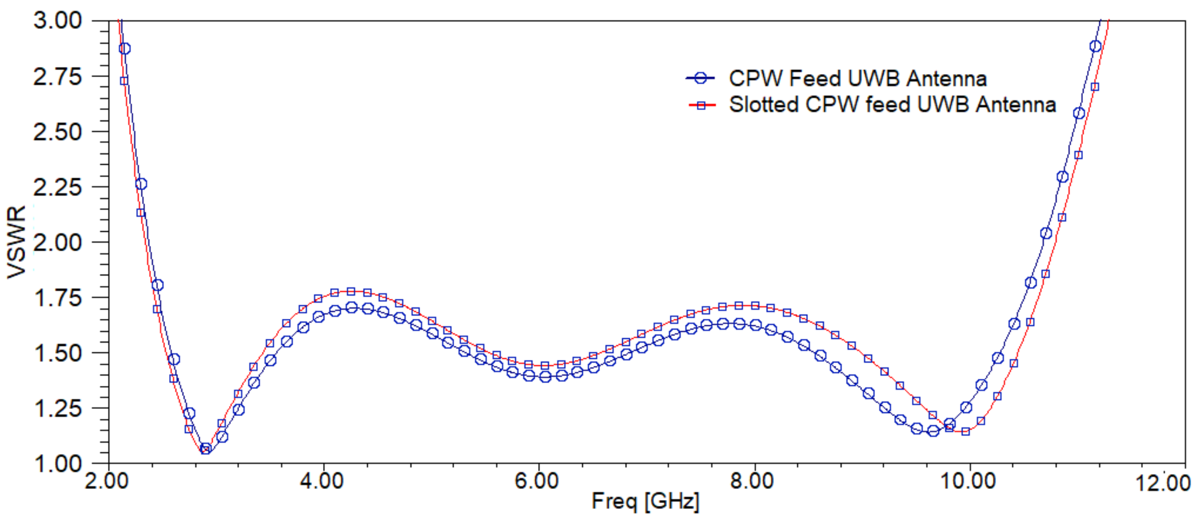


Fig. 4 VSWR variation of Antenna-1 and Antenna-2

III. GAIN IMPROVEMENT OF PROPOSED ANTENNA

Radiation characteristics of antenna is a key parameter that determines the usability of antenna for various applications. In general, if the gain of the antenna is higher, the more effectively the antenna shall radiate, meaning the farther it can transmit the signal. Several gain improvement techniques have been proposed in various literature's. As discussed earlier, closed loop currents forming on a circular radiating patch antenna can be minimized in enhance the radiation properties of the antenna. The slot in antenna-2 has improved gain compared to that of Antenna-1. Antenna-3 (as shown in Fig. 5) consists of stacked substrate over the Antenna-2. Both the substrates used in Antenna-3 are FR-4 glass epoxy. Antenna -3 further provides improved gain as compared to both Antenna-1 and Antenna-2. Antenna - 4 is a modified structure of Antenna -3 wherein a gap between Base substrate and Overlay substrate has been introduced as shown in Fig. 6

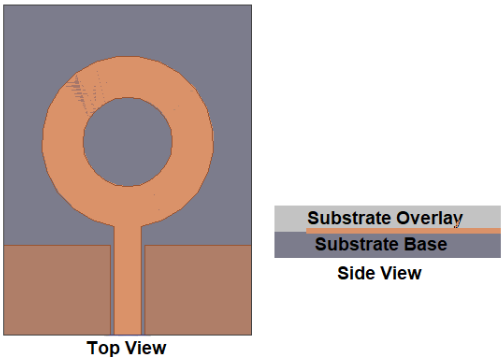


Fig.5 Antenna-3 structure with stacked substrates

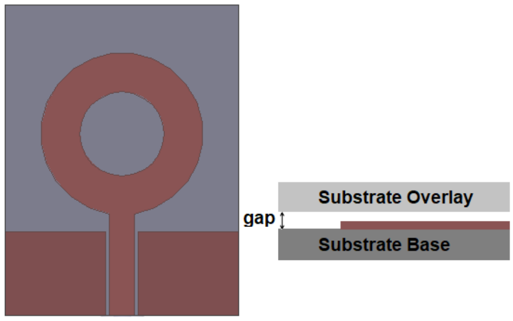


Fig.6 Antenna -4 structure with stacked substrate and gap in substrate

Fig. 7 shows variation of gain of proposed antennas (Antenna- 1 through Antenna -4). It is clearly evident that gain has improved by cutting a slot in the radiating patch. Furthermore, the gain has improved by using stacked substrate structure. By adding a gap in between the stacked substrate the gain has been improved further. Table 1 shows gain variation of Antenna-1 through Antenna-4 at sampling frequencies of 3.1 GHz, 5.5 GHz, 7.5 GHz and 10.6 GHz.

TABLE 1: Gain variation of Antenna-1 through Antenna-4 at different sampling frequencies

Proposed Antenna/ Frequency	**3.1 GHz**	**5.5 GHz**	**7.5 GHz**	**10.6 GHz**
Antenna - 1	0.6825 dB	2.2860 dB	3.8891 dB	5.0495 dB
Antenna - 2	0.8478 dB	2.2788 dB	4.0648 dB	5.6930 dB
Antenna - 3	1.3733 dB	2.3232dB	4.2644 dB	5.8740dB
Antenna -4	0.7180 dB	2.4646 dB	4.3584 dB	6.083 dB

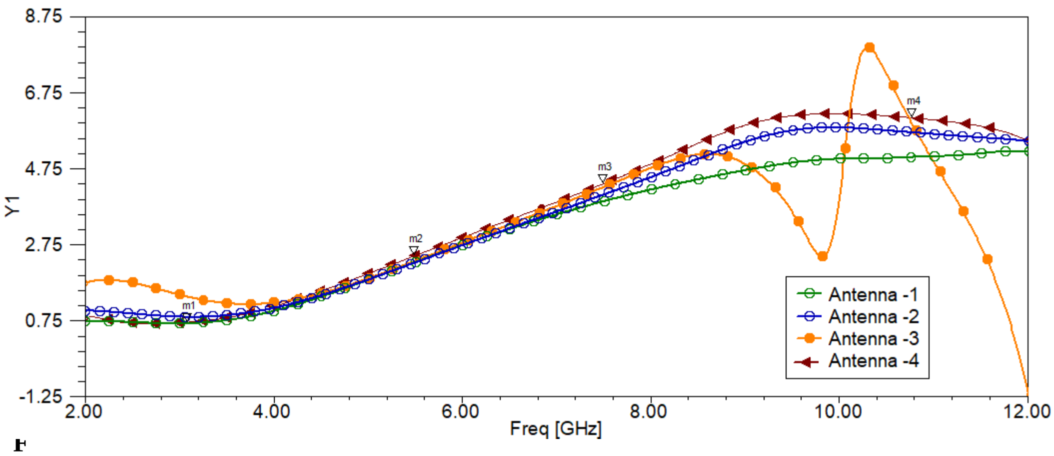


Fig. 7 Gain variation of proposed Antenna-1 through Antenna-4

IV. RESULTS AND DISCUSSIONS

Furthermore, to have more insights into operation and working of CPW feed UWB antenna we study the current distribution, radiation pattern and gain of the antenna.

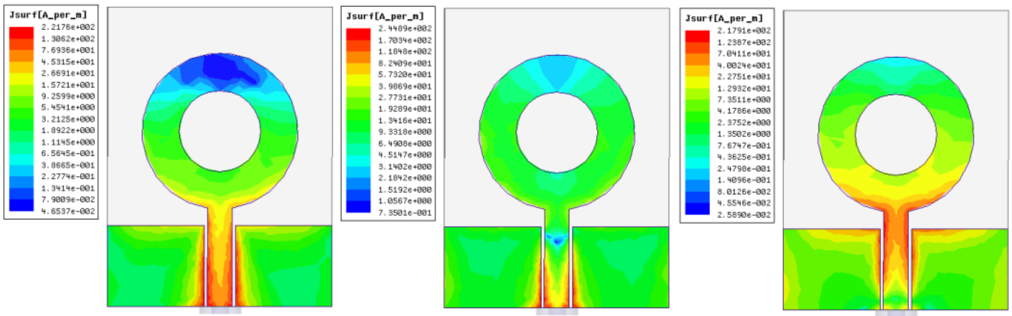


Fig. 8 Surface current distribution at (a) 3.2 GHz, (b) 5.5 GHz and (c) 7.5 GHz of slotted CPW feed UWB Antenna

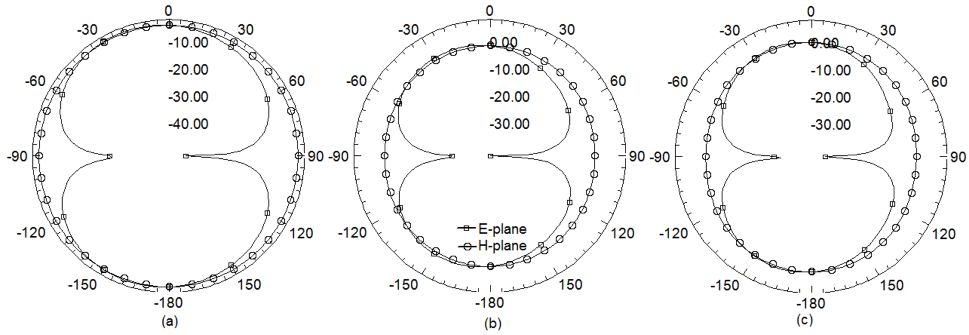


Fig. 9 Simulated radiation pattern along E plane and H plane at (a) 3.1 GHz, (b) 5.5 GHz and (c) 7.5 GHz of slotted CPW feed UWB Antenna

Fig. 8 shows the surface current distribution of the proposed antenna. The surface concentrates mainly on radiating patch at 3.1 GHz (or the lower edge frequency) and concentrates in the feed line at 5.5 GHz (or the centre frequency) and is uniformly distributed across the entire antenna geometry at 7.5 GHz (or the higher edge frequencies). Observing current distribution can help us analyze or modify the structure at certain frequencies. The simulated radiation patterns along E plane and H plane have been investigated at sampling frequencies of 3.1 GHz, 5.5 GHz and 7.5 GHz. The radiation patterns are almost omni directional along H plane and directional along E plane as shown in Fig. 9. Fig. 10 shows the simulated gain of the proposed antenna. The proposed antenna has a simulated gain of 0.781 dB, 2.4646 dB, 4.3584 dB and 6.083 dB at sampling frequencies of 3.1 GHz, 5.5 GHz, 7.5 GHz and 10.6 GHz respectively. Fig. 10 shows the fabricated prototype of the proposed antenna. Fig. 11 shows the measured VSWR results of the proposed antenna. The antenna is tested in an open environment using FieldFox Vector Network Analyzer (VNA).

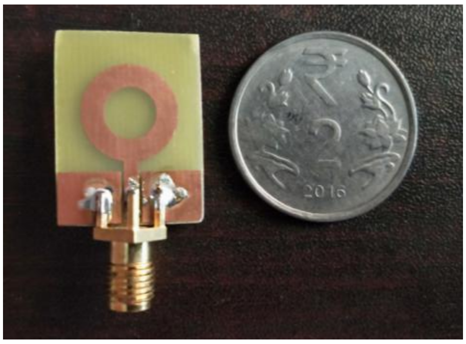


Fig. 10 Fabricated prototype of slotted CPW feed UWB Antenna

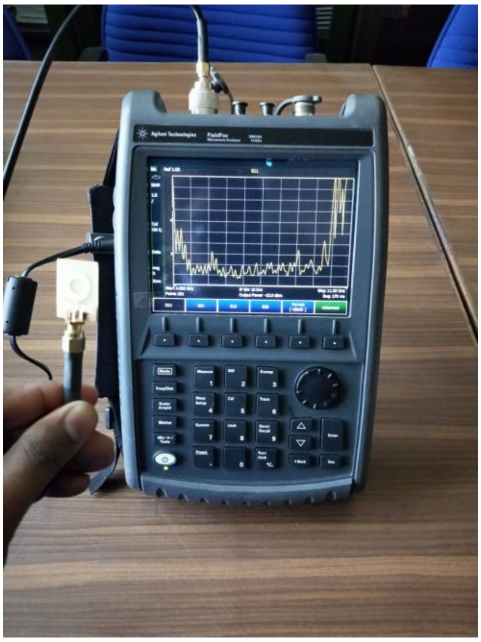


Fig. 11 Measured VSWR of slotted CPW feed UWB antenna

V. CONCLUSION

In this communication, a slotted CPW feed UWB antenna with improved gain has been designed and investigated. Furthermore, different gain improvement techniques have been studied that provides further incremental gains while maintaining the desired antenna characteristics. The proposed antenna structure is designed and fabricated on a FR-4 glass epoxy substrate and has a very compact size of 24 x 20mm^2. The fabricated prototype is tested in an open environment and offers a VSWR ≤ 2 over 3 - 10.8 GHz covering the entire UWB frequency band of 3.1-10.6 GHz as allocated by FCC. The antenna while having compact size maintains both time domain and frequency domain characteristics. This makes the proposed antenna suitable for wireless applications.

REFERENCES

[1]. Daniel Valderas, Juan Ignacio Sancho, David Puent, Ultrawideband Antenna- Design and Applications (Imperial College Press, 2011)

[2]. Labade, R., S.Deosarkar, andN.Pishoroty, “A novel integrated Bluetooth dualband UWB antenna for wireless communication,” International Journal of Microwave and Optical Technology, Vol. 10, No. 3, 195–201, 2015.

[3]. Labade, R., S. B. Deosarkar, and N. Pishoroty, “Design and implementation of an integrated Bluetooth ultrawideband monopole antenna,” Australian Journal of Basic and Applied Sciences, Vol. 15, No. 8, 60–66, 2014.

[4]. Avinash Tambe, Rekha Labade, Shankar B. Deosarkar, and Rahul Parbat, “ACS Feed Compact Multiband Antenna for Personal Wireless Communication Applications”, Progress In Electromagnetics Research Letters, Vol. 57, 31–38, 2015

[5]. Rekha Labade, Shankar B. Deosarkar, Narayan Pishartoy and Avinash Tambe, “Planar Monopole UWB Antenna for USB Dongle Application”, Progress In Electromagnetics Research C, Vol. 60, 37–46, 2015.

[6]. Federal Communications Commission, “Revision of Part 15 of the commissions rules regarding ultrawideband transmission systems,” First Note and Order, ET-Docket 98-153, Washington, DC, 2002.

[7]. K. P. Ray and Y. Ranga, “Ultrawideband Printed Elliptical Monopole Antennas”, IEEE Transaction on Antennas and propagation,Vol. 55,No.4,April 2007.

[8]. Lin, C. C., E. Z. Yu, and C. Y. Huang, “Dual-band rhombus slot antenna fed by CPW for WLAN applications,” IEEE Antennas and Wireless Propagation Letters, Vol. 11, 362–364, 2012.

[9]. Park, Sang-Yong & Oh, Seon-Jeong & Park, Jong-Kweon, “A Simple CPW-Fed UWB Antenna Design”, Journal of Electromagnetic Engineering and Science, 2010, 10. 10.5515/JKIEES.2010.10.1.013.

[10]. W. Zhou, Y. S. Li and C. Y. Liu, “Research on a CPW-Fed Ultra-Wideband Antenna,” Microwaves, Vol. 26, No. 8, 2010, pp. 234-237.

[11]. Jayesh Dharne, V. M. Kulkarni, “CPW feed UWB Antenna for Next Generation Personal Wireless Communication Devices”, IJIRT, Vol.5, Issue 10, pp 322-325.

[12]. C. A. Balanis, Antenna Theory and Analysis (Wiley Publication)
[13]. Girish Kumar and K. P. Ray, Broadband Antennas (Artech House, 2003)
[14]. Fabrs, M. C., "Systematic design of antennas using the theory of characteristic modes," Ph.D. Dissertation, Feb. 2007.

Jayesh Dharne. "Gain Improvement of CPW feed UWB Antenna for Personal Wireless Communication Applications." IOSR Journal of Engineering (IOSRJEN), vol. 09, no. 04, 2019, pp. 26-31.