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Compact Monopole for Eco Friendly Super Wide Band Antenna

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Abstract

Compact hand fan shaped monopole with microstrip line feed is presented for super wide band applications. Bandwidth (1.8GHz – 31.1GHz) is achieved by diverging the ends of microstrip line feed linearly towards the rectangular patch, a modification in the ground plane and an elongated slit in the ground plane asymmetrically with respect to the strip line. Ansoft HFSS software is used for simulating the monopole and measurements after fabrication are done using Anritsu MS2038C vector network analyzer. The maximum peak gain of the monopole is 6.5dB. The E-plane patterns are approximately directional and H-plane patterns are approximately omni directional. So, the monopole can be used as a super wide band antenna which is eco friendly. The measured S_{11} (upto 18GHz) are promising with the simulated results.

Keywords: Compact, Monopole, Super wide band, Wide band applications,Eco friendly.

1 Introduction

In current days, the growth of wireless systems is growing enormously. Apart from Ultra-Wide Band (UWB) antennae operating from 3.1GHz to 10.6GHz, there is a huge demand for Super Wide Band (SWB) antennae to operate over short and long range frequencies. Super wide band monopole is an electromagnetic sensor with bandwidth ratio more than or equal to 10:1

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impedance bandwidth at -10dB reflection coefficient [1]. With low cost, small size and large bandwidth super wide band microstrip antennae are being widely used in present communication systems. Many researchers attempted to design various SWB antennae. Okas et al. designed modified square shaped monopole with 52x46mm^2 dimensions with a bandwidth from 0.95-13.8GHz [2]. Cruz Angel Figueroa-Torres et al. fabricated a modified triangular shaped fractal antenna covering a frequency range from 1.68-26GHz with area 62x64mm^2 [3]. Farooq A. Tahir et al. introduced a hut shaped radiating patch operating between 0.9-22.35GHz with size 40x25mm^2 [4]. Murli Manohar et al. introduced a printed monopole with operating range 0.9-100GHz having sizes 30x40mm^2 [5]. Pradeep Vinaik Kodavanti et al. announced a circular monopole with bandwidth 2.36-71.6GHz having area 60x45mm^2 [6]. In this article a SWB monopole is proposed, studied various parameters and fabricated.

2 Proposed Monopole Design

Figure 1 presents the proposed monopole. The parameters of the monopole are given in table 1. The microstrip line feed is diverged towards the rectangular patch and rectangular ground plane with an elongated slit towards one end. FR4 epoxy substrate with loss tangent=0.02, thickness=1.6mm and relative permittivity=4.4 is used in the fabrication. The backside view and frontside view of fabricated monopole are presented in figure 2 with dimensions 33x35mm^2 with operating frequency 1.8GHz-31.1GHz.

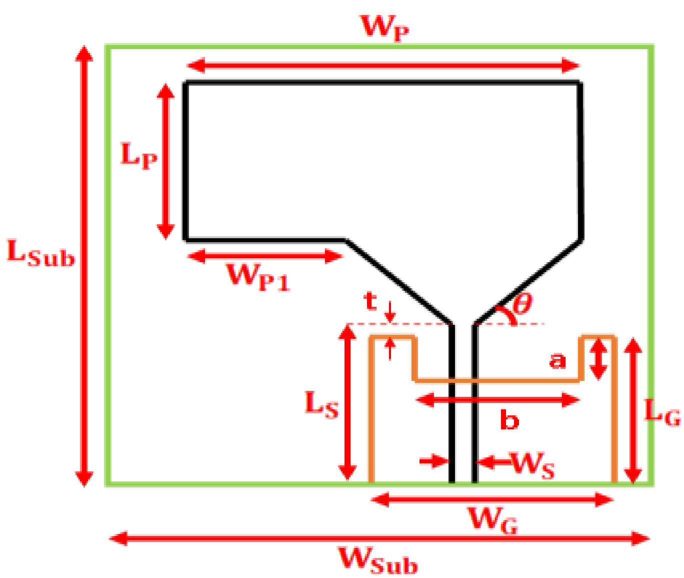


Figure 1 Proposed Monopole Backside (Orange) and Front Side View (Black)

3 Effect of Monopole Parameters

A rectangular slit was introduced on the ground plane with 'a' and 'b' as parameters. With parameter a=2.4mm fixed parameter 'b' is varied, the resultant S_{11} is shown in figure 3. It is concluded that if the slit in the ground plane is increased to one end its higher frequency of operation increases and operates for a wide band. For an optimum value of b=5.8mm, it acts as a super wide band monopole.

Table 1 Proposed Monopole Parameters

S No.	Parameters	Dimensions
1	W_{Sub}	33mm
2	L_{Sub}	35mm
3	W_P	19mm
4	L_P	15mm
5	W_{P1}	11mm
6	W_G	14.5mm
7	L_G	10mm
8	L_S	15mm
9	W_S	2mm
10	a	2.4mm
11	b	5.8mm
12	t	1.8mm
13	θ	45^o

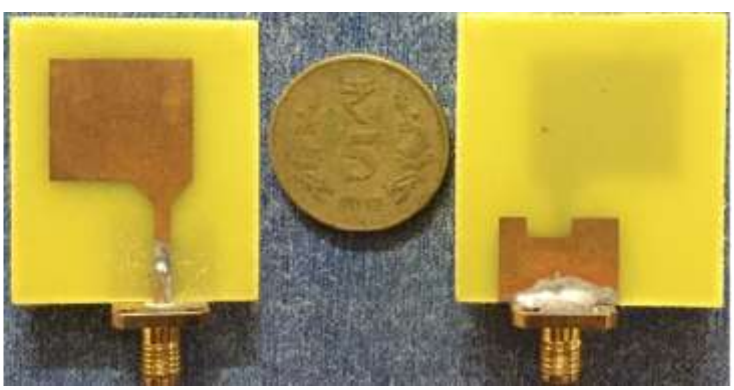


Figure 2 Printed Monopole Backside View & Frontside View

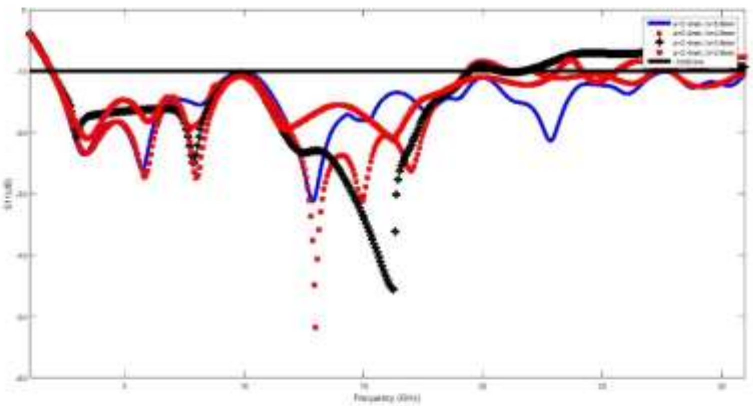


Figure 3 Reflection Coefficient of the Monopole for Various Values of ‘b’

If the parameter b=5.8mm and the value of ‘a’ is varied, the resultant S_{11} is shown in figure 4. It is concluded that with an increase in the value of ‘a’ the upper operating frequency increases. For an optimum value of a=2.4mm, it operates as a super wide band monopole. The parameter‘t’ is also varied and it is found that the monopole can be used for wide band operation as shown in figure 5. It is concluded that for t=1.8mm the reflection coefficient lies below -10dB within the operational band.

4 Results and Discussion

The measured reflection coefficient and simulated reflection coefficient are presented in figure 6. The measured S_{11} is promising with the simulated S_{11} upto 18GHz. The operational bandwidth obtained from the measurements is 1.81-18.4GHz. Hence the ratio of upper operating frequency to lower is greater than 10.

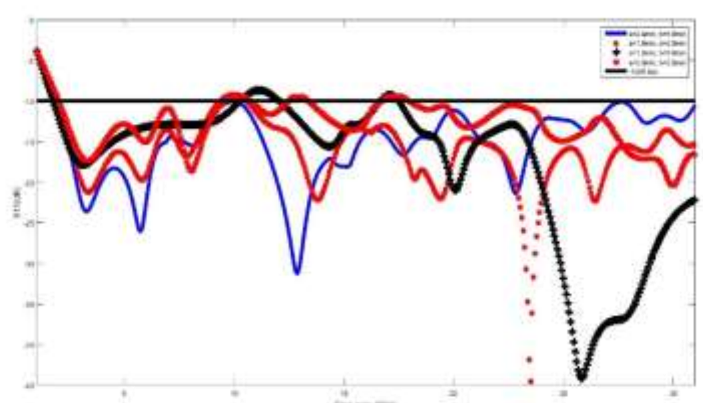


Figure 4 Reflection Coefficient for Various Values of ‘a’

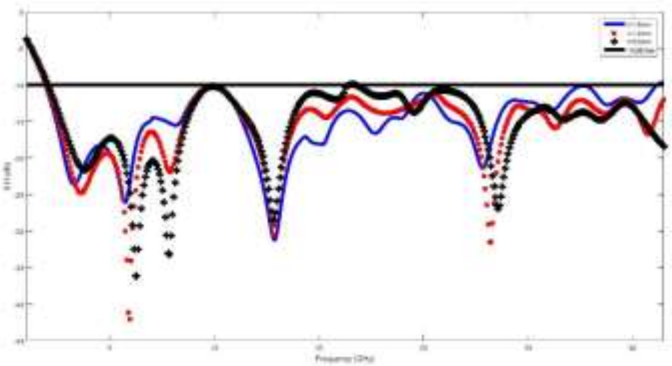


Figure 5 Reflection Coefficient for Various Values of 't'

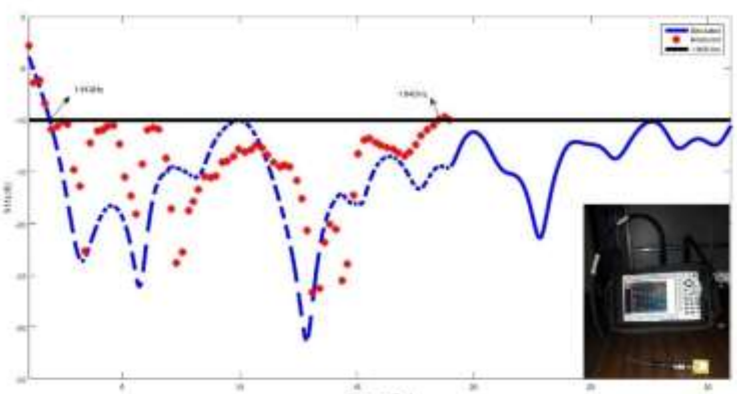
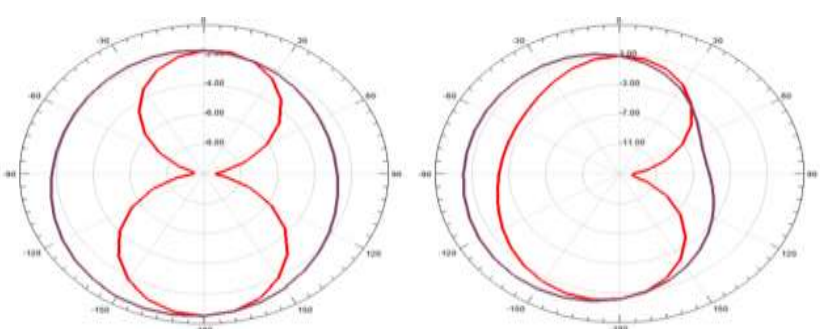
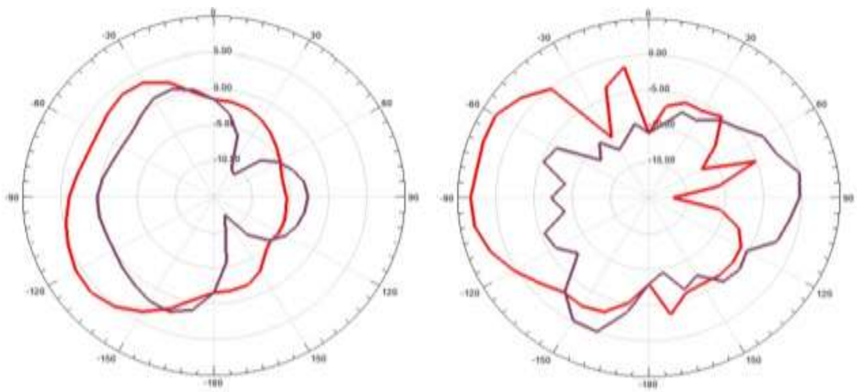


Figure 6 Measured and Simulated Reflection Coefficient

The simulated radiation patterns are mentioned in figure 7. The E-plane pattern of radiation are directional and H-plane pattern of radiation are omni directional with deviations at higher frequencies. The simulated peak gain is shown in figure 8. Comparison of various antennae are tabulated in table 2.



at 3.3GHz **at 5.6GHz**



at12.7GHz **at 22.7GHz**

Figure 7 Simulated E-Plane and H-Plane Radiation Patterns.

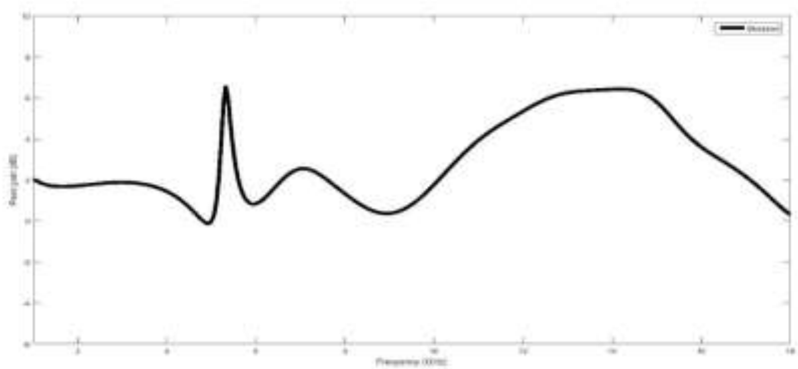


Figure 8 Simulated Peak Gain of the Proposed Monopole

Table 2 Comparison between Various Antennae

S No.	Reference paper	Dimensions	Bandwidth
1	[2]	$52 \times 46 mm^2$	0.95-13.8GHz
2	[3]	$62 \times 64 mm^2$	1.68-26GHz
3	[4]	$40 \times 25 mm^2$	0.9-22.35GHz
4	[5]	$30 \times 40 mm^2$	0.9-100GHz
5	[6]	$60 \times 45 mm^2$	2.36-71.6GHz
6	Proposed	$33 \times 35 mm^2$	1.8-31.1GHz

5 Conclusion

In this study, an earth friendly compact monopole is designed, various parameters are analyzed and fabricated for super wide band operation. A rectangular microstrip line feed is linearly diverged towards the rectangular patch and a rectangular ground with a rectangular slit, elongated asymmetrically with respect to the feed line to achieve super wide band operation. The gap between ground plane and diverging ends of microstrip line feed is also accountable for wide operational bandwidth. The overall dimensions of the antenna are 33X35X1.6mm^3 operating between 1.8-31.1GHz, approximately directional pattern of radiation in the E-plane, approximately omni-directional pattern of radiation in the H-plane and maximum peak gain of 6.5dB can be used for short and long range communications.

References

[1] M. Samsuzzaman et al., "A Semicircular shaped super wideband patch antenna with high bandwidth ratio", Microwave & Optical Technology Letters, vol. 57, no. 2, pp. 445-452, 2015.

[2] Piyush Okas et al.," Super-wideband CPW fed modified square monopole antenna with stabilized characteristics", Microwave & Optical Technology Letters, vol.60, pp. 568-575, 2018.

[3] Cruz Angel Figueroa-Torres et al.," A Novel Fractal antenna based on the Sierpinski structure for Super Wide-Band Applications", Microwave & Optical Technology Letters, vol. 59, no. 5, pp. 1148-1153, 2017.

[4] Farooq A. Tahir et al., "A Compact Hut-shaped printed antenna for super-wideband applications", Microwave & Optical Technology Letters, vol. 57, no. 11, pp. 2645-2649, 2015.

[5] Murli Manohar et al., "Super wideband antenna with single band suppression", International Journal of Microwave & Wireless Technologies, vol. 9, no. 1, pp. 143-150, 2017.

[6] Pradeep Vinaik Kodavanti et al., "Super wide band Circular shaped antenna with a slit on the Trapezoidal ground plane", ARPN Journal of Engineering & Applied Sciences, vol.14, no. 3, pp. 653-657, 2019.

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