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Design and Analysis of "AKK" Shape Slot Antenna for S-Band Application

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Abstract

*An S-band patch feed Tamil letter "AKK" shape slot antenna for RADAR application is designed and presented in this paper. The proposed "AKK" shaped slot antenna is built on an air substrate with dielectric constant of 1.0006, a dimension of patch 40.5*40.5 mm, thickness of 1.6 mm, and loss tangent of 0.00827. The proposed antenna is designed over a frequency of 3.5 GHz. The antenna is designed and simulated using IE3D software, which helps to obtain the analysis of antenna parameters such as efficiency, VSWR, directivity, radiation pattern (3D), return loss, gain and relation between them.*

Keywords: *VSWR, Gain, RADAR, Return Loss*

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INTRODUCTION

Antennas are basic components of any electric system and are connecting links between the transmitter and free space or free space and the receiver. In the world of communication basic need is an antenna. Antennas are employed in different systems in different forms. The antennas used simply to radiate electromagnetic energy in an omnidirectional or finally in some systems for point-to-point communication purpose in which increased gain and reduced wave interference are required.

Micro-strip antennas have found widespread applications in wireless communication system following to their advantages such as low profile conformability, low cost and ease of fabrication. On the other hand, traditional Microstrip antenna suffers from very narrow bandwidth with respect to the center frequency. To overcome this, slot antenna have been considered a good candidate in conforming to these trends. In order to reduce antenna size, recent research has proposed many miniaturization techniques for slot antennas. For compact slot antenna design, increasing the length of the slot[1] or adjusting the shape of the slot[2] is needed. By implanting variety shapes of the slots[3-6], the antenna size can be reduced for a given operating frequency. The important parameters of any type of antenna are impedance, bandwidth and return loss[7-8]. The S band defined by an IEEE standard with frequencies 2 to 4 GHz. Odd multiple of wavelength (33 λ) increases the radiation pattern of antenna. The S-band applications such as Satellite communication, RADAR devices[9-14], Terminal Air traffic control, Long-Range weather and Marine RADAR. In this paper sincere attempt is made to design model, optimize and analysis "AKK" slot antenna taking air as a substrate at 3.5 GHz with the help of IE3D Software.

SYSTEM MODEL

In this paper several parameter have been investigate using IE3D software[15-19]. The design specifications for the patch antenna are:

1. The dielectric material selected for the design is Air
2. Dielectric constant (ε_r) of Air is 1.0006.
3. Height of substrate (h) is 1.6 mm.

The physical dimensions of the patch are based on the following formulae[11].

$$L = \frac{c}{2 f_0 \sqrt{\varepsilon_r}} \quad \text{Eq. (1)}$$

$$w = \frac{c}{2 f_0 \sqrt{\frac{2}{(\varepsilon_r + 1)}}} \quad \text{Eq. (2)}$$

Where L is the length[12], W is the width[11] and f_0 is frequency of the proposed antenna. C is the space speed of light and ε_r is relative permittivity of substrate. The physical dimensions of the ground plane are based on the following formulae.

$Lg = 6h+L$ Eq. (3)

$Wg = 6h+W$ Eq. (4)

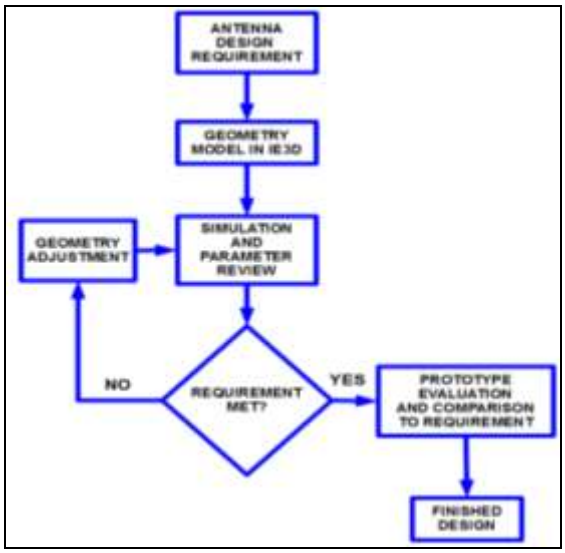

Fig. 1: *Design Flow Diagram.*

Where Lg and Wg are the length and width of the ground plane and h is the thickness of the substrate. The dimension is taken in millimeter (mm)[20-23]. Many shapes of slots are available in antenna design like U shape[9], H shape, W shape[10], circular shape[11] etc. We use square shape slots in proposed antenna. The patch feed is proposed in the antenna structure shown in Figure 2 and the design flow diagram as shown in Figure 1. The 3D view of antenna is shown in Figure 3.

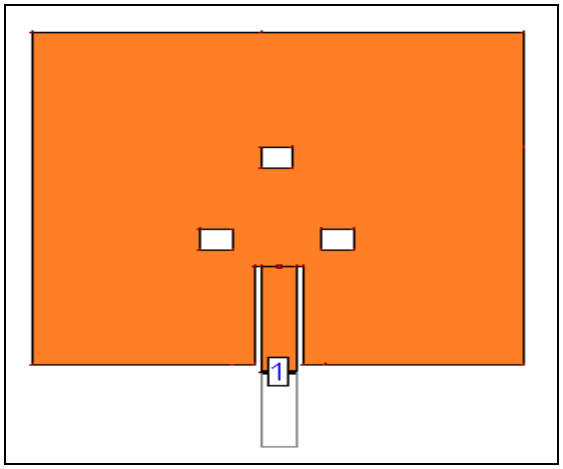

Fig. 2: *Proposed "AKK" – Shape Antenna (2D).*

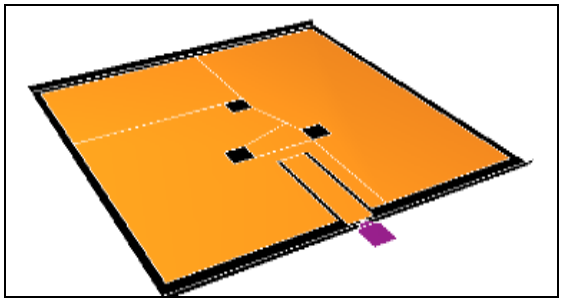

Fig. 3: *Proposed H – Shape Antenna (3D).*

The dimension of proposed antenna is given in the below Table 1.

Table 1: *Physical Parameter of Antenna.*

S. No.	Description	Value
1	Patch dimension (L*W)	40.5 * 40.5 mm
2	Slot length (L1)	2.64 mm
3	Slot width (W1)	2.64 mm
4	Feed length	13 mm
5	Feed width	3 mm
8	Relative Permittivity (ε_r)	1.0006
9	Substrate Material	Air
10	Dielectric loss tangent (tan δ)	0.00827
11	Thickness	1.6 mm

SIMULATION AND RESULTS

The proposed "AKK" shape slot antenna is simulated using IE3D simulator and various parameters (VSWR, Gain, Efficiency, Directivity, etc.) are measured. It is found that the antenna resonates at 3.5 GHz.

Return Loss

The return loss is a measurement from which we can judge how much amount of power is reflected by the antenna. The numerical value of the S_{11} space parameter from the Figure 4 is -10.25 dB.

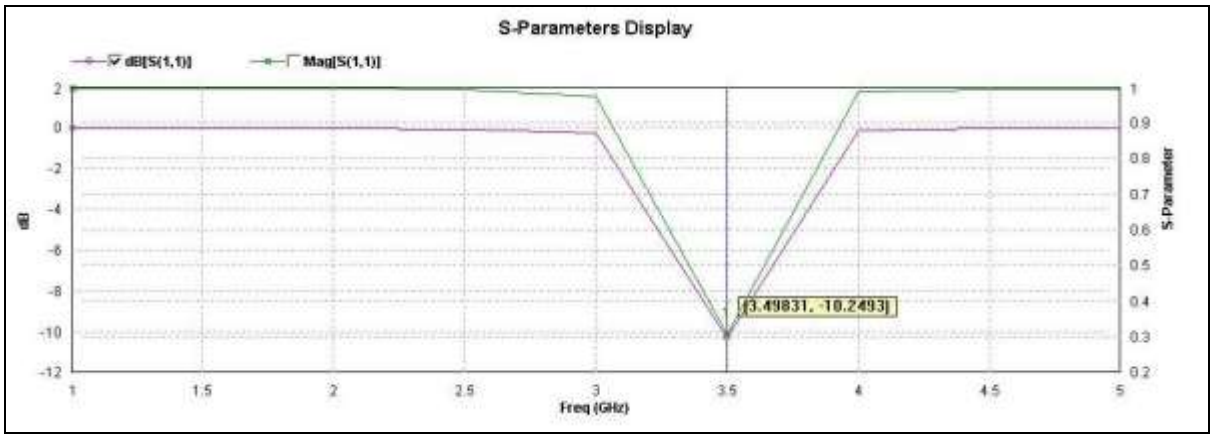

Fig. 4: *Simulated S – Parameter Value.*

VSWR

The VSWR determines the matching properties of antenna. It indicates that how much efficiently antenna is transmitting/receiving electromagnetic wave over particular band of frequencies[12,15]. It describes the amount of power reflected by an antenna. In practical, the VSWR should be between 1 and 2 for less reflection losses. The VSWR value at 3.5 GHz is 2.11 shown in Figure 5..

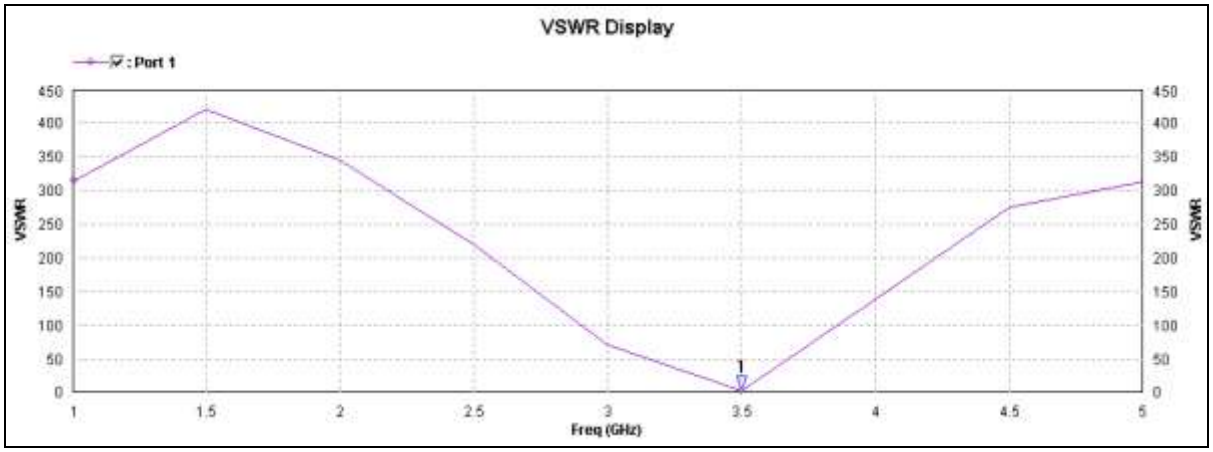

Fig 5: *Simulated VSWR Value.*

Radiation Pattern

It is a graphical representation of the radiation properties of the antenna as a function of space coordinates. Radiation pattern is an indication of radiated field strength around antenna. It is different for different antennas and is affected by the location of antenna with respect to ground. The 3D view of radiation pattern is shown in the Figure 6.

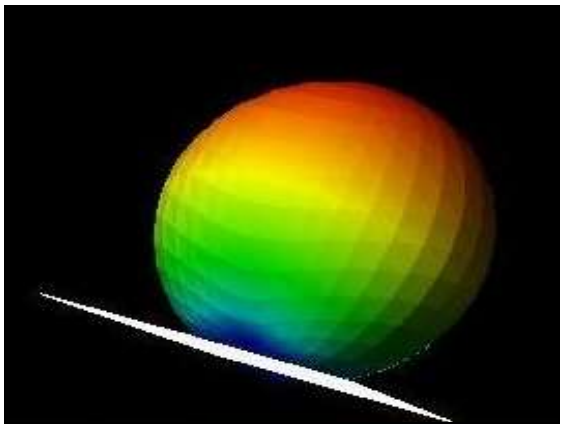

Fig. 6: *Radiation Pattern.*

The gain of proposed antenna is 8.17 dBi is equal to 12.37 dB which is shown in Figure 7.

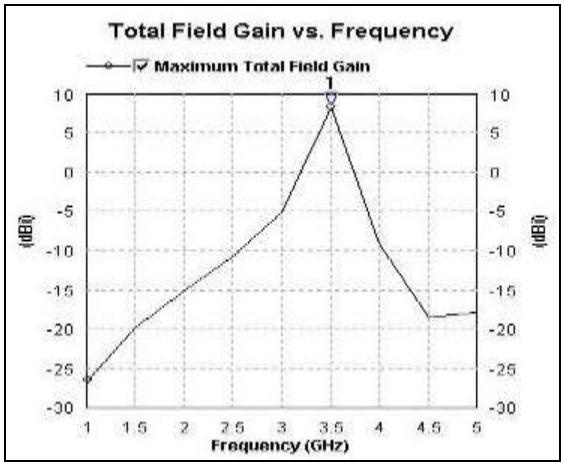

Fig. 7: *Simulated Gain Value.*

The Directivity of proposed antenna is 9.8 dBi is equal to 14.84 dB which is shown in Figure 8.

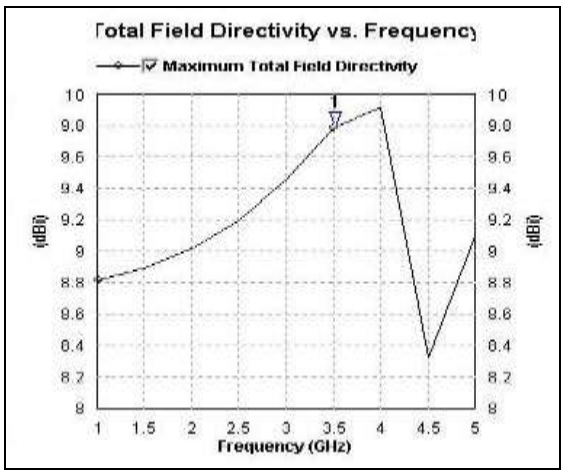

Fig. 8: *Simulated Directivity Value.*

The radiation efficiency is 76.2 % and antenna efficiency is 68.01 % which is shown in Figure 9. The above results can be tabulated in Table 2 as follows,

Table 2: *Simulated Results.*

S. No.	Performance Parameters	Observed Value
1	Return loss	-10.25 dB at 3.5 GHz
2	VSWR	2.11dB at 3.5 GHz
3	Gain	12.37 dB at 3.5 GHz
4	Directivity	14.84 dB at 3.5 GHz
5	Antenna efficiency	68.01 % at 3.5 GHz
6	Radiation efficiency	76.2 % at 3.5 GHz

CONCLUSION

This antenna has been successfully simulated and designed. The antenna was designed on Air Substrate; the results gave appreciable gain and directivity. The return loss for 3.5 GHz is -10.25 dB. The antennas which are mentioned in this paper they are being used marine RADER, Satellite communication, Terminal Air traffic control.

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REFERENCES

1. Chen R.H., Lin Y.C. Miniaturized Design of Micro-strip Fed Slot Antennas Loaded With C-Shaped Rings. *IEEE Antennas and Wireless Propagation Letters.* 2011: 10; 203–6p.
2. Ko C.H., Chiang M.J., Sze J.Y. Miniaturized Planar Annular Slot Antenna Design Utilizing Shorting Conducting Strip. *IEEE Antennas and Wireless Propagation Letters.* 2009: 8; 1360–63p.

3. Vedaprabhu. B., Vinoy K. J. A Double U-slot Antenna with Dual Wideband Characteristics. *IEEE*. 2010.
4. Balanis C.A. Antenna Theory Analysis and Design. *John and Wiley*. 2nd. Edn.: 1997; New York.
5. Kim, T.H., Park, D.C. Compact Dual-Band Antenna with Double L-Slits for WLAN Operations. *IEEE*.2005.
6. Pen C.M., Chen I.F., Yeh J.J. Printed Modified Loop Antenna for W-LAN/Wi-Max Applications. *Electronic Letters IET*. 2007: 43(5); 11–2p.
7. Ansari J.A., Dubey S.K., Singh P. *et al.* Analysis of U – Slot Loaded Patch for Dual Band Operation. *International Journal of Microwave and optical Technology*. 2008 April: 3(2); 80–4p.
8. Anitha, S. Sri Jaya Lakshmi, J. Lavanya, Habibulla Khan, K. Sireesha, N. Divya Teja, "Multiple Slotted Antenna for WLAN/HIPERLAN/2/RADAR Applications", *International Journal of Scientific and Research Publications*. 2012; 2(5): 1–4p.
9. Jyothi B., Murthy V.V.S., Kumar B.P. Design of U Slot Patch Antenna for Wi-Max and Radar Applications. *International Journal of Modern Engineering Research*. May–June 2012: 2(3); 1220–23p.
10. Kumar R., Chaubey P.N., Srikant I. On the Design of UWB Circular Fractal Antenna with Notched – Band Characteristics Using W – Shape Slot. *Journal of Microwaves, Optoelectronics and Electromagnetic Application*. 2012 December; 11(2): 230–41p.
11. Ghnimi S., Wali R., Gharsallh A. A new design of an S/X Dual band circular slot antenna for RADAR applications. *Journal of Microwave Power and Electromagnetic Energy*. 2013 June; 47(2): 138–46p.
12. Muchhal N., Vishway A. A compact double U slotted micro-strip patch antenna for GSM and Wi-Max Applications. *International Journal of Communication Engineering Applications*. June 2013; 4 (F072): 545–48p.
13. Balanis C.A. Antenna Theory Analysis and Design. *Wiley India*. 2005: 3rd Edn.
14. Kraus J.D., Antennas. *Tata McGraw Hill Company Limited*. 1997: 2nd Edn.
15. Verma A. Analysis and Design of E Shaped Patch Antenna in X Band. *International Journal of Advanced Engineering Technology*. March 2012; 3(1): 223–4p.
16. Das A., Das S.K. Microwave Engineering. *Tata McGraw Hill Company Limited*.2010: 2nd Edn.
17. Liu C.Y., Jiang T., Li Y.S. A Compact wide slot antenna with dual band notch characteristics for Ultra Wideband Applications. *Journal of Microwaves, Optoelectronics and Electromagnetic Applications.* June 2011: 10(1); 55–64p.
18. Skolnik M. I. Introduction to Radar Systems. *Tata McGraw Company Limited*. 2007: 2nd Edn.
19. Veereshappa M., Mulgi S.N. Design and development of L Slotted, Monopole Notch band Rectangular Microstrip Antenna. *International Journal of Electronics Engineering*. 2012: 4(1); 17–20p.
20. Rao V.V., Prasad P.S. Design of Squinted Beam Slotted Liner Array Antenna for RADAR Application. *International Journal of Science and Research*. 2013 May; 2(5): 469–72p.
21. Ain A.F., Qasaymah Y.M., Ahmad Z.A. *et al.* An Equivalent Circuit of Microstrip Slot Coupled Rectangular Dielectric resonator Antenna. *Progress in Electromagnetics Research Symposium proceedings.* March 27–30, 2012: Kula Lampur, Malaysia; 1837–40p.

22. Kerarti Z., Jalal D., Mouhamed M.S. New Diamond Antenna for Ultra Wideband Applications. *International Journal of Computer Science.* July 2012; 9(4): 387–90p.
23. Khan F., Kumar R. Design and Analysis of Rectangular Micro-strip Patch Antenna. *International Journal of Engineering and Advanced Technology*, 2013 June: 2(5); 308–10p

BIOGRAPHY

V. Koushick was born in India, T.N in 1990. He received his B.E degree from Anna University Tiruchirappalli in 2011. He received his Post graduate diploma in VLSI Design from Annamalai University Chidambaram in 2011. He received his M.E. degree from Anna University Chennai in 2014. From 2011 to 2012 he worked as lecturer and from 2014 to till date he is working as Assistant Professor in Electronics and Communication Engineering. He is an Editorial Board Member of International Science and Research Journals. His research areas include Antennas, RF and Microwaves, Radars, and VLSI.