ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.3

Design of T-Shaped Slot Antenna for Radar Applications in Automobiles

Malarkodi .D[1], Manjurekha .G[2], Priyanka .P[3], Radhika.I[4], Amudhan .M[5]
B.Tech Student[1, 2, 3, 4], Assistant Professor[5]
Department of Electronics and Communication Engineering
Achariya College of Engineering Technology, Puducherry, India

Abstract:
This paper presents a design of microstrip slot antenna used for Short Range Radar (SRR) applications at 24.1 GHz in automobiles. The antenna consists of a T-shaped slot antenna simulation and measurement with a bandwidth of over 500MHz in the operation band. The antenna characteristics are studied. The antenna is designed using an Ansoft HFSS simulator and is fabricated using FR4 epoxy substrate with the thickness of 1.6mm and relative permittivity of 4.4 using a dual side Printed Circuit Board (PCB) technology. The Antenna provided good performance of functional parameters such as return loss and VSWR. Thus the antenna will be effective for Blind Spot Information Systems (BLIS) applications in automobiles.

Key words: Slot antenna, SRR, BLISS, return loss.

I. INTRODUCTION

In recent days, evidently without doubt the airbag and window bag systems have significantly reduced the number of accidents in automobiles. Accident analysis, however, shows that in two thirds of all accidents a fairly long phase with a critical driving situation precedes the actual impact. A first step toward making use of this phase is realized for the first time with PRESAFE. PRESAFE has now seen its first series application in the 2003 S-Class, and combines active and passive safety. The system recognizes critical driving situations with increased accident possibility. It triggers preventive measures to prepare the occupants and the vehicle for possible crash by evaluating the sensors of the Electronic Stability Program (ESP) and the Brake Assist (BAS). Reversible belt- pretensioners for occupant fixation, passenger seat positioning and sunroof closure are activated. However, these are merely first steps in the new and evolving safety technology. Next generation vehicles will additionally take the near-range environment into consideration. Short Range Radar (SRR) is thus expected to be the key enabling technology. Placing 24GHz SRR sensors around the car leads to a “virtual safety belt” allowing to explore several safety and assistance functions, such as collision warning, precrash sensing, preferring preconditioning of restraints and airbags, lane change aid, stop & follow, stop & roll, recognition of traffic members, Blind Spot Detection (BSD), parking aid and pedestrian protection. The new technology is designed to eliminate the cause of those injuries and deaths by providing a warning when there is something in a vehicle’s blind spot. BSD made its debut in 2007 on a Volvo S80; it is now a common feature on many vehicles. BSD has two variations: active and passive, and of course each manufacturer has developed their own way of doing things, and naming them uniquely with their own acronyms. Ford calls its system Blind Spot Information System. (BLIS). Nissan calls it the BSW (Blind Spot Warning). GM calls it Side Blind Zone Alert. Provided are the acronyms that are currently being used by the various technologies but their goal toward the system remains the same. They ensure to monitor the vehicle’s blind spot area and alert drivers from an unseen object traveling beside them. For this problem we designed an antenna to avoid accidents at the safety radar frequency of 24 GHz.

II. ANTENNA DESIGN

A. STRUCTURE OF SLOT ANTENNA

A slot antenna consists of a metal surface, usually a flat plate, with one or more holes or slots cut out. When the plate is driven as an antenna by a driving frequency, the slot radiates electromagnetic waves in a way similar to a dipole antenna. A slot antenna's main advantages are its size, design simplicity, and convenient adaptation to mass production using either waveguide or PC board technology. Figure.1 shows a typical structure of a slot antenna.

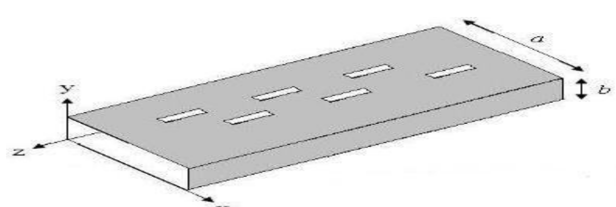


Figure.1. Structure of Slot antenna

B. GEOMETRY OF THE ANTENNA

Figure 2 illustrates the structure of the microstrip slot antenna proposed in this paper. A microstrip slot antenna is chosen in this work for its planar structure and integration is flexible with other microwave structures used in automobile applications. The antenna is developed on a FR4 epoxy substrate with dimensions 19*28*1.6 (B*L*W) all in mm. Fig illustrate the fabricated prototype of the proposed antenna.

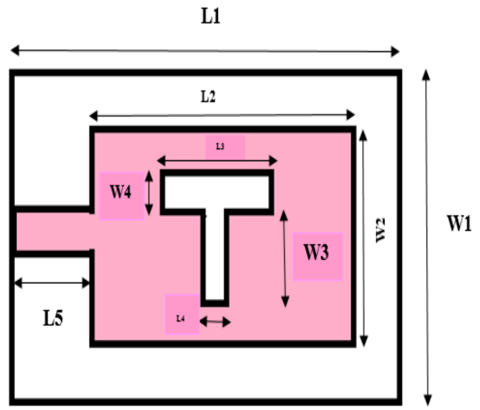


Figure.2. Geometry of the antenna

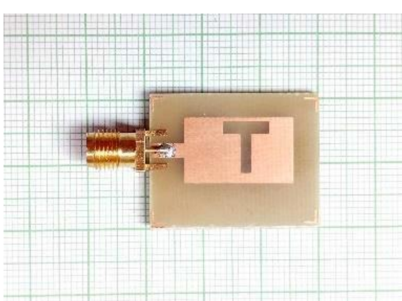
In this work, the antenna is simulated using Ansoft HFSS simulator to obtain S-parameter (S11) and VSWR. Table 1.shows the dimensions such as length and width of the Antenna.

Table .1.1 dimensions of the antenna

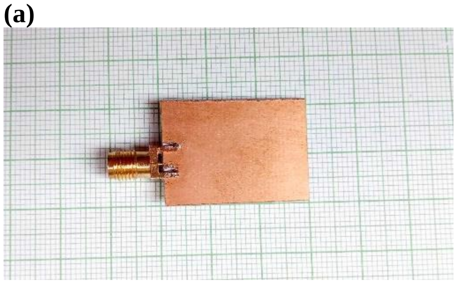
DESCRIPTION	DIMENSIONS (mm)
L1	28
L2	18.5
L3	8
L4	2
L5	5.5
W1	19
W2	10
W3	6
W4	2

III. RESULTS AND DISCUSSION

The snapshot of fabricated microstrip antenna is shown in *Fig.6. (a)* & (b).



(a)



(b)

Figure.6. A Snapshot of Fabricated Antenna : (a)Top View (b)Bottom View

The proposed antenna is first assessed in free space prior to its performance evaluation on a car model. Return loss (S11) is obtained at about −16dB within the operating frequency band. The measured 10dB impedance bandwidth is found to be approximately 500MHz (23.8 ~ 24.3GHz). Thus, the bandwidth is obtained at the frequency of 24.1GHz.

A. RETURN LOSS

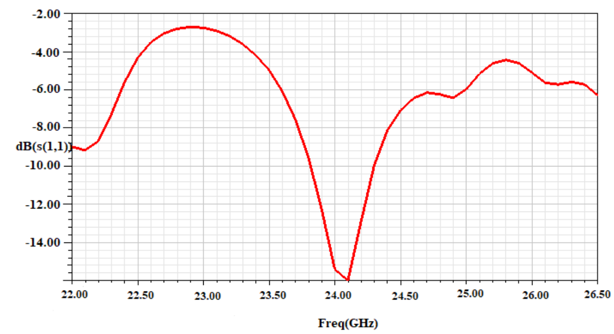


Figure. 3 Return loss of T-shaped Slot antenna.

Figure. 3 shows the measured return loss of proposed antenna at a frequency of 24 .1GHz at -16 dB. Return Loss is the loss of power in the signal returned by a discontinuity in a transmission line or optical fiber and is calculated by,

RL(dB) = 10log10 Pi / Pr

Where RL(dB) is the return loss in dB, P_i is the incident power and P_r is the returned power.

B. VSWR

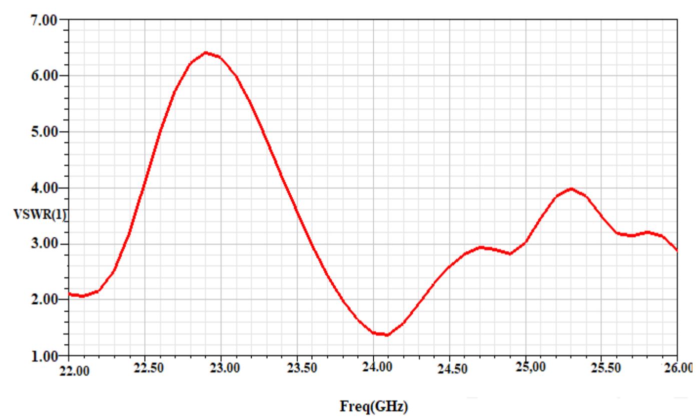


Figure.4. VSWR of T-shaped Slot antenna

Figure 4 shows the measured VSWR of proposed antenna at a frequency of 24.1 GHz at 1.4096. VSWR is a measure of how efficiently radio frequency power is transmitted from a power source, through a transmission line, into a load. Its value must be equal to ONE.

C. RADIATION PATTERN

Fig.5 shows the radiation pattern of the designed antenna at a frequency of 24.1 GHz at -21.8333 dB. Radiation Pattern defines the variation of the power radiated by an antenna as the function of the direction away from the antenna.

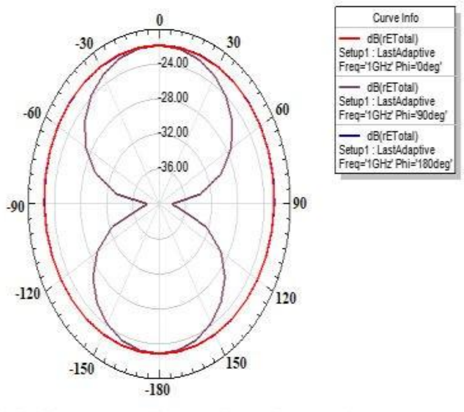


Figure.5. Radiation Pattern of Slot Antenna

IV.COMPARATIVE RESULTS

The proposed slot antenna is compared with the Microstrip Franklin Array Antenna (MFAA) designed for SRR applications in vehicle BLIS systems. The bandwidth of the proposed slot antenna is 500MHz which is comparatively better than the measured bandwidth of the MFAA device which gives 250 MHz over the operation band of 23.8~24.2GHz. The size of the developed slot antenna is also compact in size compared to the MFAA device. Also, the substrate used for fabrication in the proposed slot antenna is FR4 epoxy which is comparatively more feasible than R04003. The comparative study with the MFAA device is listed in Table 2.

Table.2. Comparison of Slot antenna with MFAA.

PARAMETERS	EXISTING SYSTEM	PROPOSED SYSTEM
SIZE	90mm*25m*0.203mm	19mm*28mm*1.6mm
BANDWIDTH	250MHz	500MHz
FREQUENCY	23.8-24.2 GHz	23.8-24.3 GHz
RETURN LOSS	-20db	-16db
SUBSTRATE	Rogers RO(4003)3.55	FR4 epoxy

V. CONCLUSION

In this paper a microstrip slot antenna for SRR applications is presented. The proposed antenna covers a single band with center frequency at 24.1GHz. The result and graph shows that the Slot Antenna has a impedance bandwidth of 500 MHz over the operation band of 23.8~24.3 GHz. The parameters of the Slot Antenna were used to obtain the optimum resonant frequency. It is then placed in front door of the car model and examined in terms of return loss, and VSWR.

VI. REFERENCES

[1]. Chia-Hsu Kuo, Chun-Cheng Lin, and Jow-Shiun Sun, ”Modified Microstrip Franklin Array Antenna for Automotive Short-range Radar Application in Blind Spot Information System”,2017.

[2]. Abdulrahman S. M. Alqadami1, Mohd F. Jamlos1, 2, *, Imtiaz Islam 1, Ping J. Soh 1, Rizalman Mamat2, Khairil A. Khairi1, 3, and Adam Narbudowicz4,5,”Multi-Band Antenna Array Based on Double Negative Metamaterial for Multi Automotive Applications” ,2017,vol.159

[3]. Mohammad Mosalanejad1, 2, *, Steven Brebels 2, Charlotte Soens2, Ilja Ocket1, 2, and Guy A. E. Vandenbosch1,” Millimeter Wave Cavity Backed Microstrip Antenna Array for 79 GHz Radar Applications”,2017,vol 158.

[4]. V. Rabinovich and N. Alexandrov, “Introduction, in Antenna Arrays and Automotive Applications”, New York, USA: Springer, 2013, ch. 1, sec. 1, pp. 1–18.

[5]. R. H. Rasshofer and K. Naab, “77 GHz long range radar systems status, ongoing developments and future challenges,” EURAD 2005 Conf. Proc. – 2nd European Radar Conf., vol. 2005, pp. 181-184, 2005.

[6]. J. Wenger, “Automotive radar – status and perspectives,” Tech. Dig. – IEEE Compound Semiconductor Integrated Circuit Symp., pp. 21–24, 2005.

[7]. A. Loeffler, S. Heinrich, T. Fechner and J. Ronczka, “24 GHz series production short range radar for highly automated driving applications,” 2015 IEEE MTT-S Int. Conf. on Microw. for Intell. Mobility, 2015.

[8]. Holger H. Meinel, “Evolving automotive radar – from the very beginnings into the future,” 8th European Conf. on Antennas and Propag., pp. 3107–3114, 2014.

[9] . S. Nishimura, K. Nakano, and T. Makimoto, “Franklin-type microstrip line antenna,” Antennas and Propag. Soc. Inter. Symp., pp. 134-137, 1979.

[10]. P. P. Wang, M. A. Antoniades, and G. V. Eleftheriades, “An investigation of printed Franklin antennas at X-band using artificial (metamaterial) phase-shifting lines,” IEEE Trans. on Antennas and Propag., vol. 47, no. 4, pp. 3118–3128, 2008.

[11]. T. A. Milligan, “Microstrip Antennas,” in Modern Antenna Design, 2nd ed. New Jersey, USA: John Wiley & Sons, Inc., 2005, ch. 6, sec. 13, pp. 332–333.

[12] . http://www.gizmag.com/go/2937/