PRINTED MONOPOLE L-BAND PATCH ANTENNA FOR SIDE LOBE BLANKING FOR RADAR APPLICATIONS

Sanjay Choube, Dy General Manager, Trapti Kumari, Senior Engineer
Development & Engineering -Antenna
Bharat Electronics Limited, Bharat Nagar, Ghaziabad (U.P.) 201010
sanajychoube@bel.co.in
traptikumari@bel.co.in

Abstract

This paper presents a Printed Monopole Square Patch Antenna in L-band for Omni Radiation Pattern. The Monopole Antennas are widely used in communication systems and their use in Radars is not common. The proposed antenna is intended to be used for side lobe blanking in Receive mode for Radar applications. Printed Monopole antennas are easy to fabricate and are cost effective when substrate like FR4 grade Glass Epoxy are used.

I INTRODUCTION

The Monopole Antennas are widely used in communication systems. Their Omni directional radiation provides all around coverage. The printed monopole antenna offers several advantages over conventional monopole antenna. Printed Monopole antennas are easy to fabricate and are cost effective when substrate like FR4 grade Glass Epoxy are used.

Theoretically the patch size is determined by the wave length. The typical Patch size for printed monopole is Quarter Wavelength. The L-band frequency band is designated from 1 to 2 GHz. The L-band radars are typically in the frequency range of 1.1 to 1.5 GHz with bandwidth of the order of 200 MHz.

II. DESIGN

The center frequency for the design is chosen as 1.3 GHz. The free space wavelength at 1.3 GHz is calculated as $\lambda = c/f = 300/1300 = 57.7$ mm.

The substrate material selected is FR4 which has a typical dielectric constant of 4.4. The patch is chosen as Square in shape for compactness.

Initially the patch size was taken 28 mm which is quarter wavelength for dielectric constant of 4.4 ($\lambda g =. \lambda/\sqrt{\epsilon r}$). As for monopole antenna size of Ground Plane is critical, The antenna must have enough ground plane to be efficient, and ideally the ground plane should spread out at least a quarter wavelength, around the feed point. Therefore the length was chosen as approximately $\lambda/2$. The width of ground plane has been decided based on structure compactness. Fig-1 depicts various dimensions of the design.

(a) Patch Size (a): 27x27 (mm)

Dimension (mm)					**Frequency (GHz)**				
b	**d**	**c**	**e**	**g**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**
12.3	10	115	3	2.3	-1.3	-2.1	-3.3	-4.8	-6.5
12.3	10	125	3	2.3	-1.5	-2.5	-4.0	-6.0	-7.6
					Return Loss (dB)				

Table-1: Simulated values of Return Loss/VSWR

(b) Patch Size (a): 57x57 (mm)

Dimension (mm)					**Frequency (GHz)**				
b	**d**	**c**	**e**	**g**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**
12.3	10	115	3	2.3	-6	-8	-11	-13	-16
13.3	10	115	3	3.3	-7	-8	-10	-11	-13
12.3	10	125	3	2.3	-7	-9	-11	-14	-17
					Return Loss (dB)				

Table-2: Simulated values of Return Loss/VSWR

(c) Patch Size (a): 71x71 (mm)

Dimension (mm)					**Frequency (GHz)**				
b	**d**	**c**	**e**	**g**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**
13	8	125	8.8	5	-25	-15	-12	-11	-9.6
11	8	125	8.8	3	-19	-23	-17	-15	-14
15	8	125	8.8	7	-15	-11	-8.9	-8.1	-7.3
					Return Loss (dB)				

Table-3: Simulated values of Return Loss/VSWR

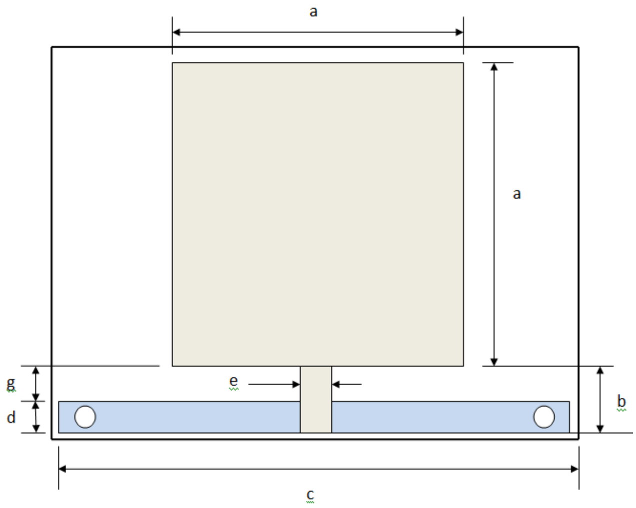

Fig-1

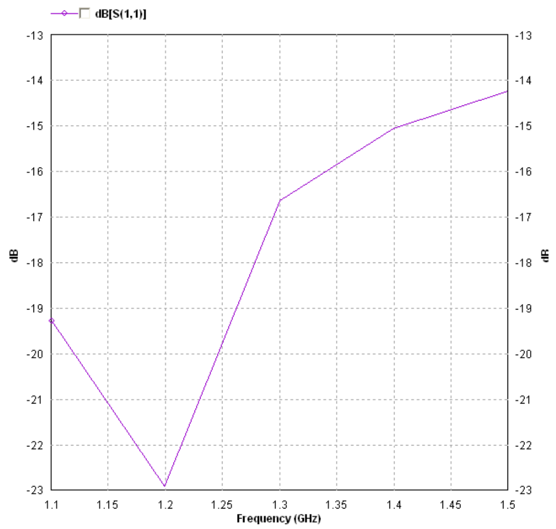

Fig-2

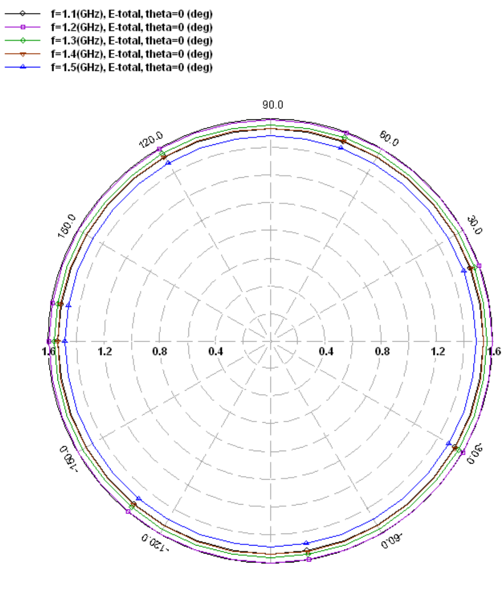

Fig-3

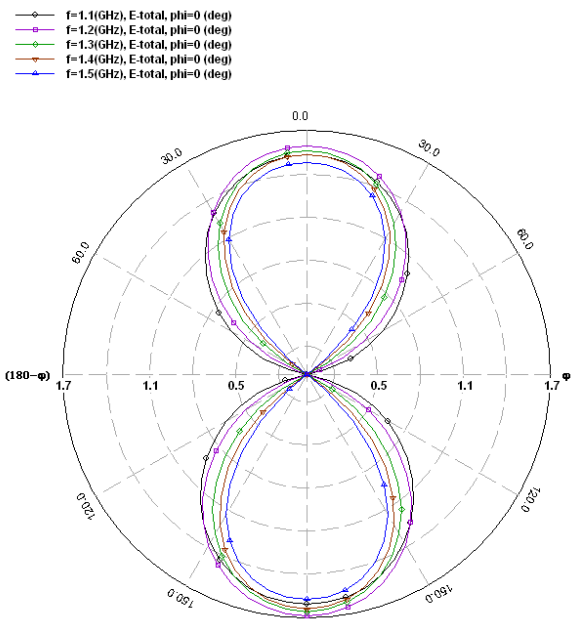

Fig-4

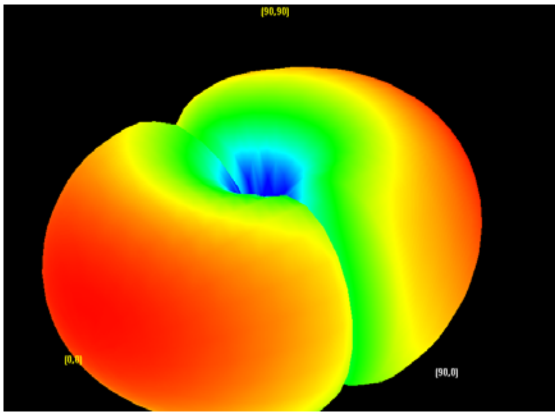

Fig-5

III. SIMULATION & OPTIMISATION

A quarter wave antenna and ground plane combine to form a complete resonant circuit at the desired operating frequency. Since this plane is the other half of the antenna, its size and proximity are essential. A compromised ground plane affects antenna stability, performance and operating frequency. Tuning of the antenna is done by optimising the gap between patch and the ground plane.

The design is simulated using RF simulation tool IE3D. Initially patch size corresponding to guided wave length was simulated for reference and results of VSWR/Return Loss are tabulated in Table-1. The patch size was increased to free space wave length where significant improvement in VSWR observed. Effect of gap ‘g’ between the patch and ground plane and also the length of ground plane studied. Selective values are tabulated in Table-2. As depicted in table-2, the bandwidth is not achieved. Further iterations were carried out for patch dimensions, width of feed line ‘e’ and gap ‘g’ between the patch and ground plane. The selected iterations are tabulated in Table-3. For the dimensions of Patch Size 71x71, b=11, c=125, d=8, e=8.8 and g=3 mm the antenna showed good VSWR for the entire frequency band of 1.1 to 1.5 GHz meeting the bandwidth of 400 MHz which is 30.7%. Simulated Return Loss/VSWR plot is shown in Fig-2. The simulated H and E plane radiation patterns are shown in Fig-3 &4. The 3 D intensity plot is as shown in Fig-5.

IV. REALISATION OF PROTOTYPE

The PCB fabrication was carried out with tighter tolerances. Two L-angle of Aluminium of appropriate size were attached to the ground plane on either side of the substrate. RF connector of N type female was mounted over to the Al angles and then soldered to the feed line. The prototype is as shown in Fig-6 & 7.

V. CONCLUSION

Study, Design and Simulation of Printed Square Patch Monopole Antenna in L-Band is presented. The antenna is realised on a standard 1.6 mm thick FR4 substrate with a typical dielectric constant of 4.4 relative to air. The Design has been successfully validated by prototype realisation. The measured Radiation Patterns in the Far Field are in close match with the simulation results in IE3D. The measured pattern is similar to Dipole Antenna. The achieved bandwidth is 30.7 %.

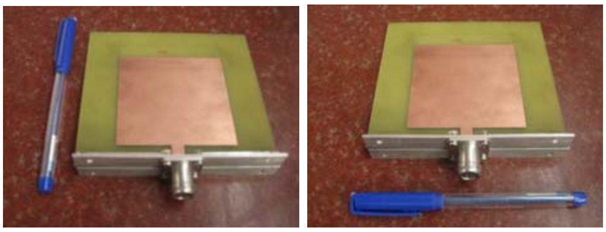

Fig-6&7

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BIO DATA OF AUTHOR(S)

Sanjay Choube is an Hons Graduate in Electronics & Telecommunication Engineering. Initially he served M/s CEL, Sahibabad (U.P) and had significant contribution in Design & Production of PCMs for Passive Phased Arrays. Presently he is working with M/s BEL, Ghaziabad as DGM in D&E-Ant and is involved in antenna designs for various radar projects.

Trapti Kumari received B.Tech Degree in Electronics & Communication from IET Lucknow in June 2007. She joined BEL, Ghaziabad in July 2007 and presently working as Senior Engineer in D&E-Ant. Her interest are in RF & Microwave component and Passive & Active phased array antenna.