Novel Monopole Antenna with H-Slot for RCS Reduction Applications

Deedar Ali Jamro, Farman Ali Mangi, Imran Memon, Riaz Ahmed Shaikh, Saeed Ahmed Khan

***Abstract*—In this paper a novel monopole antenna with H- shaped slot is examined and realized for the purpose of radar cross section (RCS) reduction. The goal of innovative configuration is to acknowledge the radar cross section reduction by parametric examinations. The conversion of circular patch into octagonal made antenna sizing on a greatly reduced scale, that attribute for RCS reduction. Moreover H-shaped slit on the patch of antenna enhance impedance matching and to contribute for RCS reduction as well. The simulated examination provides an idea that at height of substrate hs = 0.8 mm RCS well improved, while Scattering-parameter degrades. However at hs = 1.6 mm antenna parameters i.e. S-parameter, gain and RCS are in coherence. These outcomes demonstrate that the proposed model gives a decent prospect to low RCS antennas in military and defense applications**

Keywords*—Impedance Matching, Monopole Antenna, Radar Cross Section (RCS), Scattering

I. INTRODUCTION

In military and defense applications RCS reduction of targets has significant significance in order to stay away from location by Radar [1]. Antenna scattering is inducing importance on account of its attribution to the total RCS of stealth platforms. The antenna is a good scatter and its scattering relies on the feeding ports, which causes to affect antenna geometry from reducing RCS and balancing of its performance as well [2].

The goal of stealth innovation in this manner comprehends the control of the attributes of targets signal so consequently makes it hard to identify, thus protect it from being assaulted in stealth platforms [3].

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For low observable (L.O) plate forms, a standout amongst the most critical contributing source of targets RCS is the scattering due to on board antennas, hence it is crucial to control the RCS of antenna. However, the routine radar absorbing materials (RAM) coating methods are not utilized in these circumstances, because they will badly degrade antennas efficiency [4].

The radar cross section reduction (RCSR) of printed antennas depends upon the deduction of metallic regions of small current. Nonetheless, in these analyzes the RCS were not reduced in the entire working frequency. But only in high frequency range the RCS reduction of structures occurred because of their comparatively small geometric sizing. Besides, in lower frequencies, the geometrical scaling of antennas stays the same. Hence for reported research, the radar cross section reduction for low frequency range is insufficient to fulfill the requirement [5].

Therefore, the RCSR is the basic consequence to be worked out especially for low frequency range. The proposed design with H-slot is concentrated on for talked about issues, taking into account referenced antenna [6]. The miniaturization of antenna is studied for RCS reduction applications. An octagonal radiating patch having small effective area is introduced instead of circular patch. By so doing, the effective area of the antennas in the system decreases which significantly enhances RCS.

This paper is classified as takes after: In section- 2 a mathematical method for determining the total RCS of antenna and its scattering field feed with different loads is presented. Section-3 describes antenna structure and its working mechanism. Section-4 presents the discussion of methods and modeling for simulated and depicted results of the design [7-10].

II. THEORITICAL ANALYSIS

When electromagnetic waves fall on objects, the energy is dispersed in the space, it is termed as scattering. The antenna radar cross section is classified into the structural mode ($\pm_s$) and antenna mode ($\pm_a$) R CS. The total RCS is established by [11]:

$$\pm = \left|\sqrt{\pm_s} + \sqrt{\pm_a}\, e^{j¤}\right|^2 \quad (1)$$

Where is phase difference between the modes [13].The antenna scattering field with different loads is given by the equation [12]:

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$$\overline{E^s}(Z_l) = \left[\frac{(1-\Gamma_a)\overline{E^s}(\infty)+(1+\Gamma_a)\overline{E^s}(0)}{2}\right] + \left[\frac{\Gamma_l}{1-\Gamma_l\Gamma_a}\frac{1-\Gamma^2{}_a}{2}\left(\overline{E^s}(\infty)-\overline{E^s}(0)\right)\right] \qquad (2)$$

In equation (2), Γ_l is the reflection coefficient of load and Γ_a is the reflection coefficient of antenna. The RCS (±) of antenna can be computed from equation (1) [13-14].

III. ANTENNA STRUCTURE

The structure of novel design is demonstrated in Fig.1. At the octagonal patch, the letter H-like slot has two cuts along Y-axis each of width *W = 3.5mm* and length *L = 14mm*, the other cut is along X-axis of *L =W= 6mm*. The feed line and the radiating patch are on one side of the substrate while on its opposite side is the ground of *L = 17mm* and *W = 52mm*. The substrate is loaded with dielectric constant of $\varepsilon_r = 4.6$. The ground is blended at border sides so as to prevent small changes in transmitting radiation.

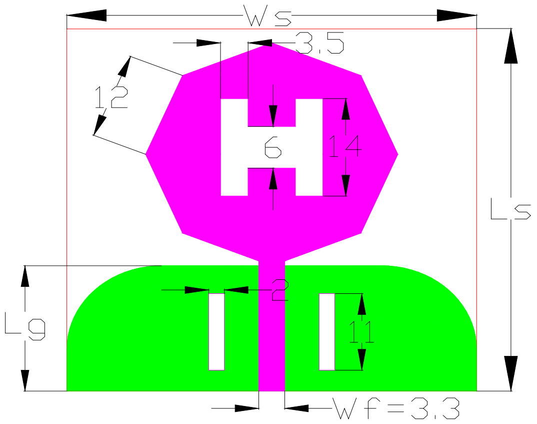

Figure 1: Structure of proposed antenna

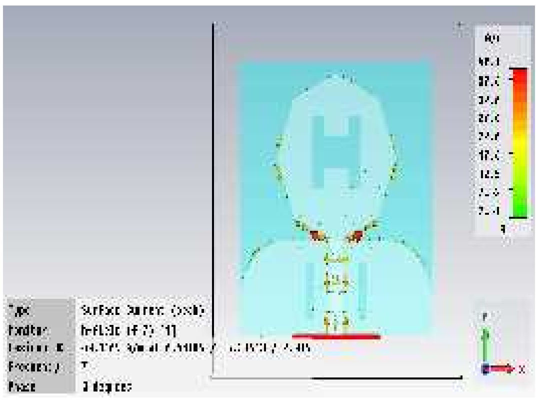

Figure2: Surface current distribution in proposed antenna

IV. RESULTS AND DISCUSSION

The simulations are done based on CST (Computer Simulated Technology) software. The conversion of circular patch into an octagonal makes size reduction of the designed model. The red cones shows the maximum distribution of the surface current from the end point of feeding line as depicted in Fig.2. At the center of radiating patch a minimum current has been found, therefore a letter H is chosen as to enhance impedance matching and miniaturize antenna sizing which contribute to reduce RCS as well.

The cuts on the ground changes over magnetic flux and so induces currents, herby these cuts behave like resistance matching circuit as to keep the antenna efficiency constant

The required S11 of two curves blue and black of the proposed design is obtained in the whole working frequency as cover satellite, microwave relay and Radar applications as shown in Figure.3. However, these curves have reasonable incoherence around the frequency of 10GHz for UWB applications. It has been found from simulations that the scattering parameter degrades with decrease of height of substrate and vice versa as shown in Figure.3. The gain of referenced and proposed antennas are almost the as sown in Figure.4 in.

The RCS has well improved value at hs = 0.8 mm as shown in Fig.5. Therefore decrease of height of substrate make RCS bettered and vice versa. Hence it is highly challenging to make bettered all the antenna parameters at same height of substrate. Meanwhile at hs = 1.6 mm the return loss, gain and the RCS are has been improved as shown in Fig.3, Figure.4 and Figure.5 respectively. The RCSs values of proposed design with open- circuit and short -circuit loads are depicted in Fig.6. Moreover these circuits implies infinite and zero resistances respectively. These values are used to determine total antenna RCS and RCS modes as well. These out comes and analysis suggest that the novel design can be conveniently used where low RCS property is urgently needed.

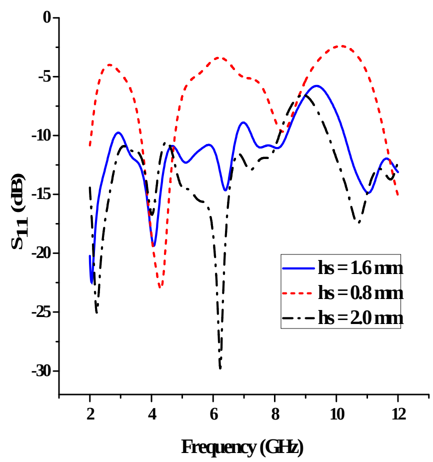

Figure 3: Return loss curves of the novel antenna

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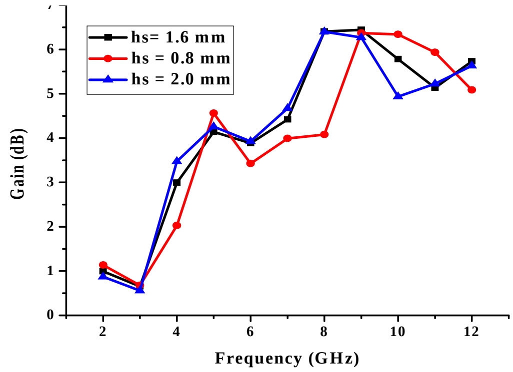

Figure 4: Gain curves of the proposed antenna

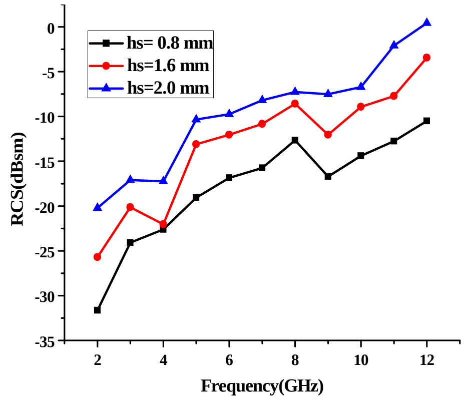

Figure 5: RCS values of the proposed antenna at different hs.

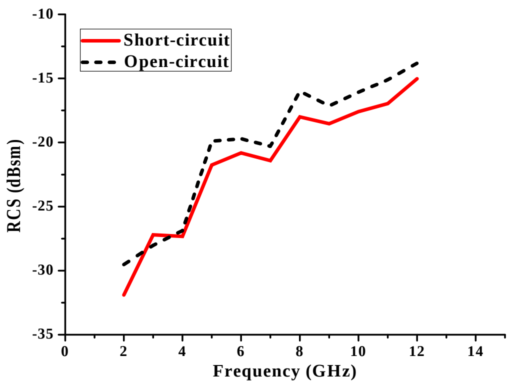

Figure 6: Simulated RCS values of the proposed antenna with different kinds of loads.

V. CONCLUSION

The novel design with reduced RCS has been inspected in this paper for C-band, X-band and UWB-band applications. After careful simulations it has been found that the designed model has optimized RCS values at hs= 0.8mm in the entire working frequency band. The outcomes demonstrate that the designed model provide the possibility of future success for low RCS antenna applications.

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