



MICROSTRIP PARASITIC STRIP LOADED RECONFIGURABLE MONOPOLE ANTENNA

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ABSTRACT

In this work a compact S-shaped monopole antenna is designed to operate in the wide band range from 7 to 16 GHz. The S-shaped radiating element is divided into different sub blocks and later microstrip parasitic strips are used to unite the independent blocks. Different orientations of strips and without strip loaded configurations are examined in this work for tunable applications. The shift in the center resonant frequency is absorbed from all these iterations with the conditions of switch positions in ON and OFF modes and the results are examined with respective to operating frequency band. The proposed antenna with all strips in ON condition is prototyped on FR4 substrate and tested on ZNB 20 VNA for validation.

Keywords: parasitic strip, monopole antenna, reconfigurability, tunability, wideband, FR4.

1. INTRODUCTION

With the current research trends which require more than one wireless application in one device, has increase the demand on the design of multiband and reconfigurable antennas for wireless application [1-4]. Reconfigurable antennas usually have the capability in which more than one resonance frequency could be achieved. Using switches different shapes of the radiating element can be created to excite different frequencies [5-8].

A reconfigurable antenna is an antenna capable of modifying dynamically its frequency in a reversed manner and as well as controlled manner and the reconfigurable antenna contains inner mechanisms such as RF switches varactors or tunable materials when this tunable materials such as switches will be varied in ON and OFF condition so that the required modifications are done to the antenna these reconfigurable antennas are widely used to maximize the performance of the antenna to reach the changing requirements and they help to reduce the number of antennas to each application because reconfigurable

antenna itself is used for multiple applications by using its tunable materials [9-12].

2. ANTENNA GEOMETRY

The geometry and different iterations of designed antenna models are shown in Figure-1. This figure will give the clear idea regarding ON and OFF condition of different strips, which are acting as switches in the designed configuration. Antenna model -1 consisting off switch off conditions with gaps in the radiating element Antenna model 2 shows switch ON condition at a particular position and switch off condition at Other locations Antenna model 3 consisting of 2 ON switches and 1 off switch. Antenna model 4 consisting of all switches in ON condition. The designed models are operated with parasitic strips as switches in ON and OFF conditions. The switch off condition is represented with gap between radiating elements and switch on condition is represented with gap loaded strips Figure-2 SHOWS the geometry of the proposed antenna model with parasitic strips in switch on condition all the dimensions of the designed model are tabulated in Table-1 the dimensions.

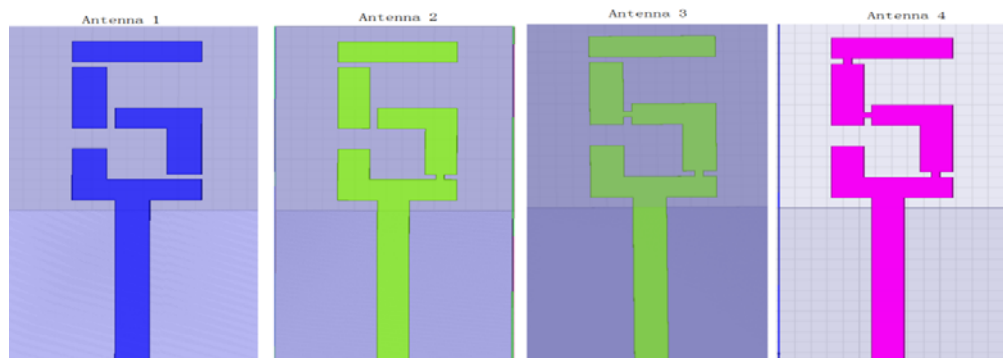


Figure-1. Reconfigurable antenna models 1 to 4.

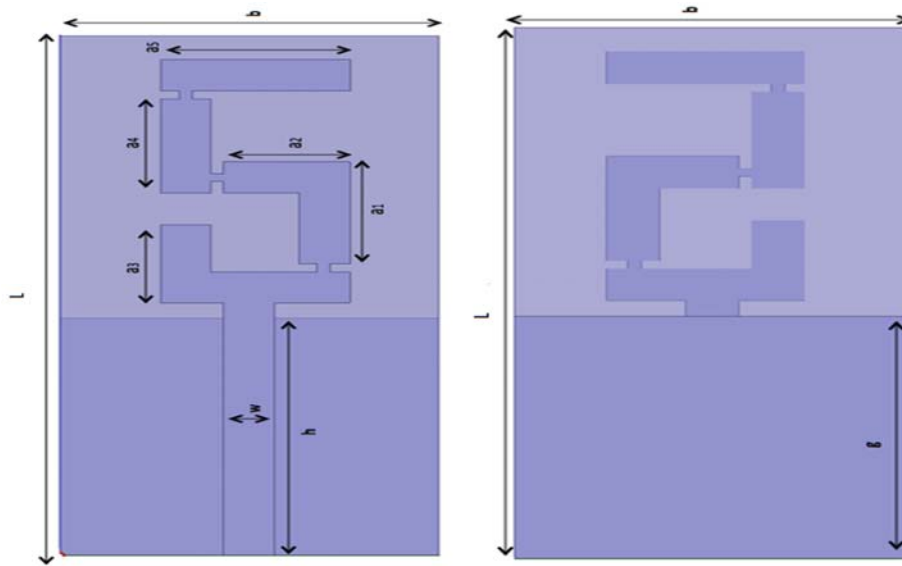


Figure-2. Proposed antenna geometry, (a) Front view, (b) Back view.

Table-1. Antenna dimensions.

Dimensions (in mm):

| L | b | h | w | a1 | a2 | a3 | a4 | a5 | g |
|----|----|----|---|-----|----|----|----|-----|----|
| 33 | 15 | 16 | 2 | 6.5 | 5 | 5 | 6 | 7.5 | 15 |

3. RESULTS AND DISCUSSIONS

Antenna models are designed using finite element method based HFSS tool for all the designed models the antenna parameters like return loss, gain, radiation pattern and field distributions, are analyzed and presented in this section. Figure-3 shows the reflection

coefficient characteristics of the designed four antenna models. It is observed that all the antenna iterations are working in the wide band more or less. With the bandwidth of 9.6GHz, antenna model 1 is showing a minimum return loss at 8.8GHz and antenna model 2 is showing minimum value at 10.75 GHz between antenna 1 and 2.

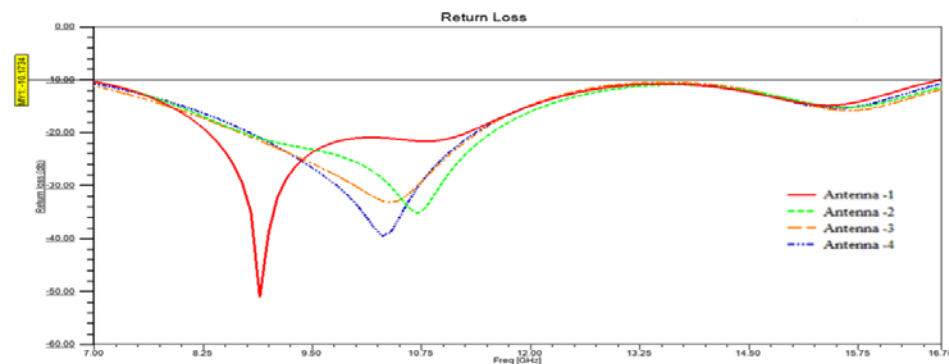


Figure-3. Return loss Vs Frequency.

The central resonant frequency shifting of 1.95GHz is observed from the figure of antenna model 3 is showing center resonant frequency minimum value at 10GHz whereas antenna model 4 is showing the minimum value at 10.5 GHz. By analyzing reflection coefficient characteristics of the designed models, a frequency shift of considerable variation can be absorbed in all these iterations. We examined the positions of switches with ON

and OFF conditions with respective resonant frequency. A frequency tunable operation is attained in the experimental design. Figure-4 shows the impedance characteristics of the antenna models with respective operating frequency operating frequency band. Antenna model-4 is showing superior impedance characteristics compared to other models (Ideal Impedance is 50 ohms).

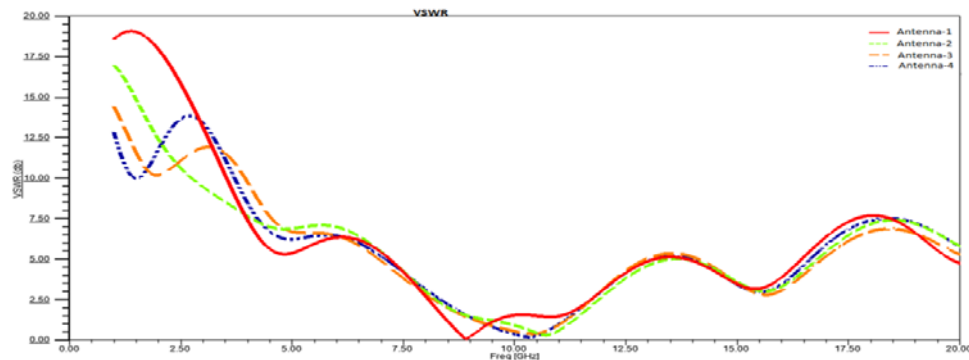


Figure-4. VSWR Vs Frequency.

Figure-5 shows the VSWR characteristics of all the antenna iterations. All the models are showing 2:1 ratio of VSWR in the operating band. Figure-6 shows the radiation pattern of the antenna model -1. A quasi-Omni directional radiation pattern can be observed from H-Plane and dipole like radiation in E-plane for antenna model-1.

Figure-7 shows the radiation characteristics of antenna model-2 with Omni directional radiation pattern in H-plane and monopole like radiation in E-plane. Figure-8

and Figure-9 shows the radiation characteristics of antenna model 3 and 4. Antenna model 4 showing Omni directional direction in H-plane in loss crosses polarization. A dumbbell like radiation pattern can be observed from the E-Plane characteristics of proposed model. The field distributions of the designed antenna models at a particular operating frequency are presented from figure 10 to 13.

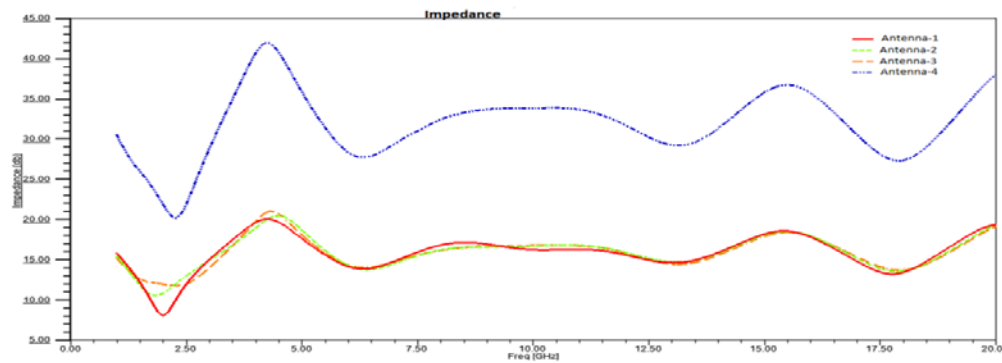


Figure-5. Impedance Vs Frequency.

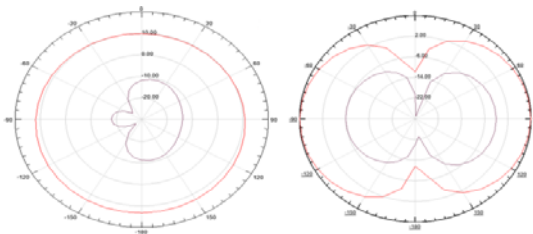


Figure-6. Radiation pattern of antenna 1.

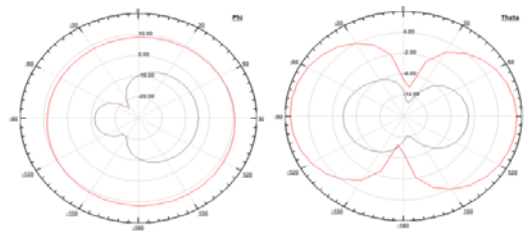


Figure-8. Radiation pattern of antenna 1.

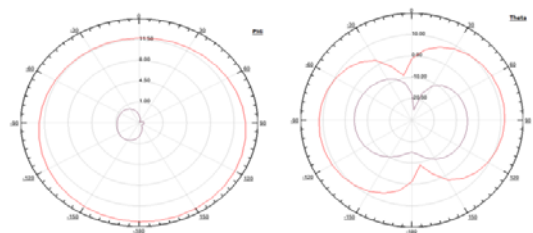


Figure-7. Radiation pattern of antenna 2.

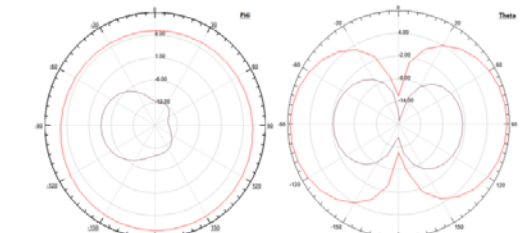


Figure-9. Radiation pattern of antenna 2.

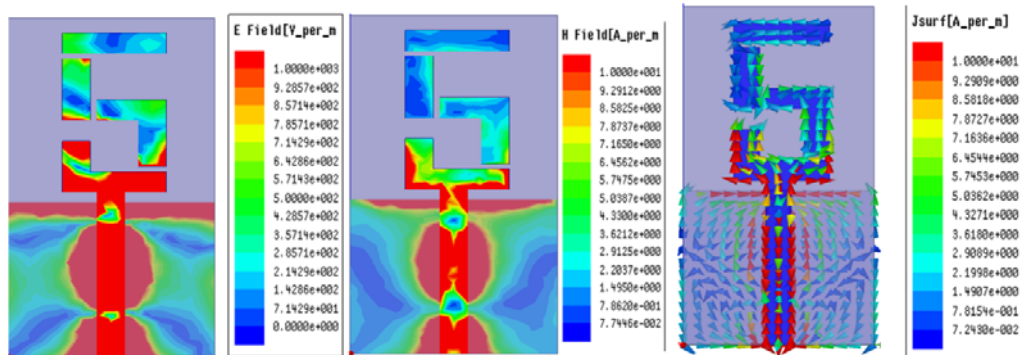


Figure-10. E-Field, H-Field and Current distribution plots of antenna model 1.

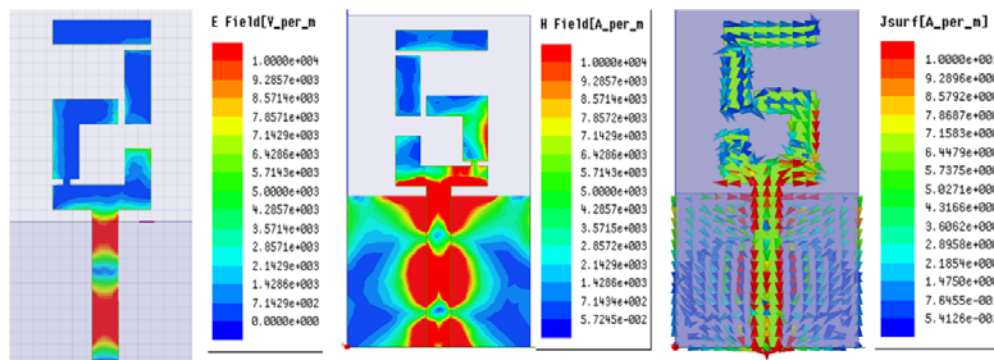


Figure-11. E-Field, H-Field and Current distribution plots of antenna model 2.

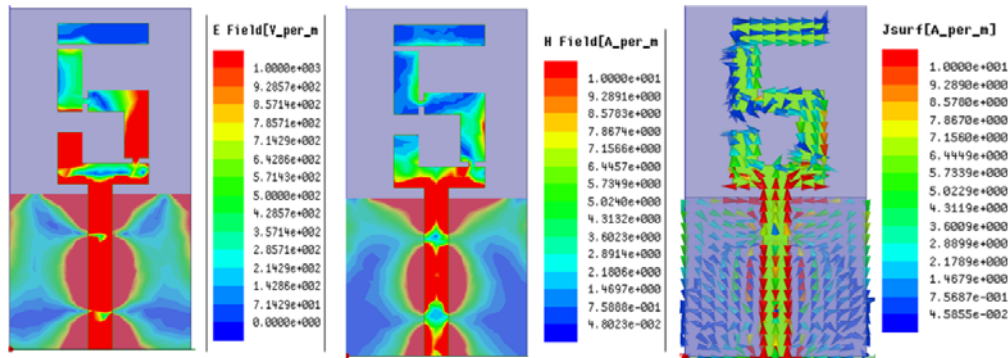


Figure-12. E-Field, H-Field and Current distribution plots of antenna model 3.

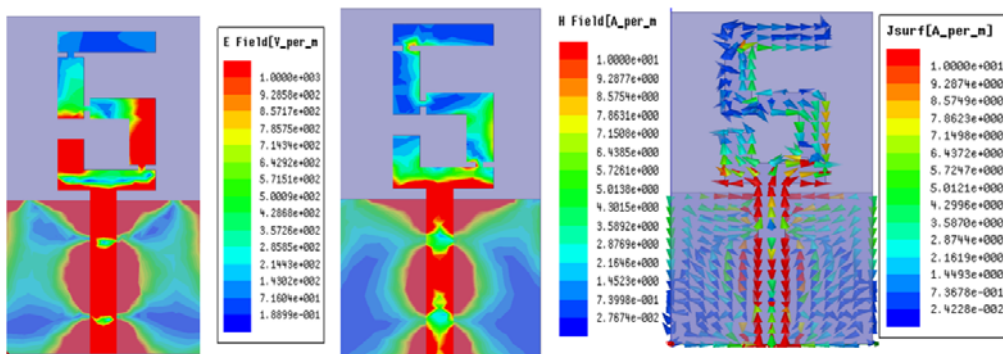


Figure-13. E-Field, H-Field and Current distribution plots of antenna model 4.



Antenna model 1 is showing cancelation of radiation on the feed line and linear polarization on the bottom side of the radiating element. Antenna model 2 most of the radiation from upper part of the feed line and lower part of the radiating element .the radiation on the bottom side of the feed line will be cancelled because of

equal magnitude in opposite direction meeting at center point. Antenna model -4 is showing superior radiation characteristic's with high intensity and current distribution on the radiating element and the feed line. Figure-14 shows the gain characteristics of the deigned models with respective operating frequency.

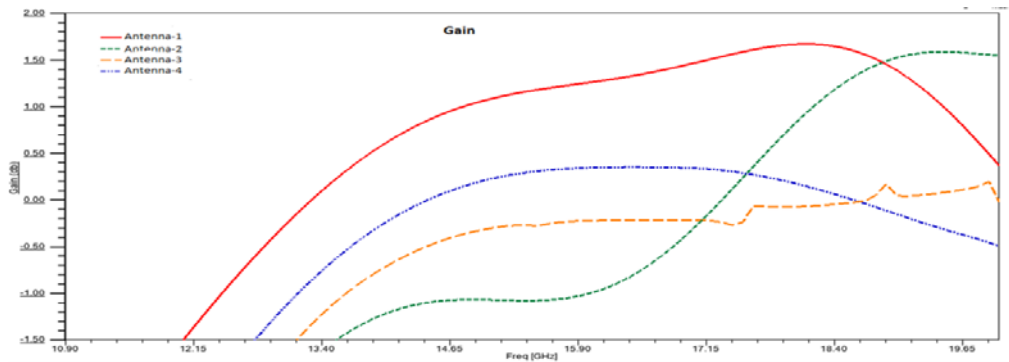


Figure-14. Gain Vs Frequency of antenna models.

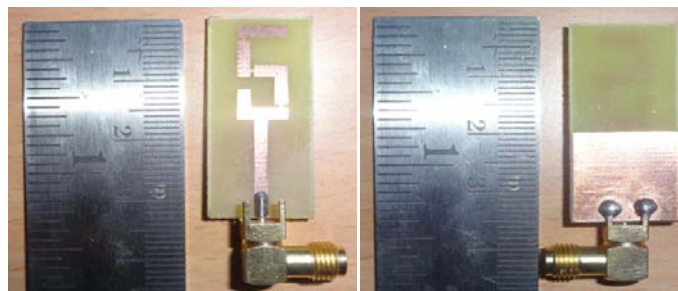


Figure-15. Fabricated antenna on FR4 substrate, (a) Front view, (b) Back view.

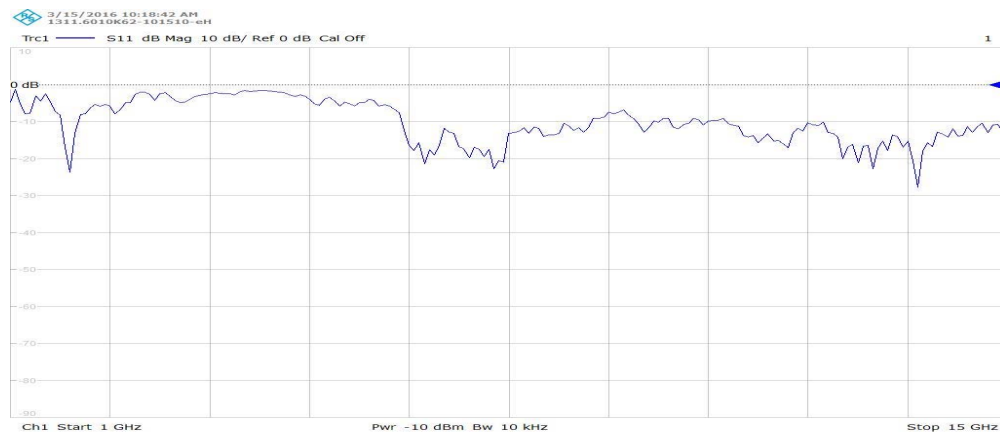


Figure-16. Measured S11 of the proposed antenna on ZNB 20 VNA.

The proposed antenna of model 4 is fabricated on FR4 substrate with dielectric constant 4.4 and presented the photograph front view and back view in Figure-15. The measured results of S11 are presented in Figure-16 and the results are almost similar to the simulation results obtained from HFSS.

4. CONCLUSIONS

A compact S-shaped monopole antenna is designed to operate in the wide band range from 7 to 16 GHz. The on and off conditions of the strips are examined as switching operations and at each stage the corresponding reflection coefficients are analyzed. The proposed antenna model 4 is giving excellent gain



characteristics and bandwidth in the desired band. All the antenna models are showing 2:1 VSWR in the operating band with good impedance bandwidth and radiation characteristics. Prototyped antenna model on FR4 is providing stable characteristics similar to HFSS model and test results are presented in this work for validation purpose.

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