# A Rectangle Novel Multiband Patch Antenna For Satellite Applications

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***Abstract:***

**In this paper, we present a new multiband patch antenna array structure. The proposed antenna is designed for Ku, K and Ka satellite applications. The configuration of array antenna in the form of a set of a rectangular novel, fed by microstrip line. The antenna designed is printed on a partial ground plane, and the resulting antenna has been found to possess a compact size of 20 mm x 20 mm, and covers specific bands from the frequency spectra.**

**The first band resonant frequency is located at about 13.26GHz, with -10dB impedance bandwidth from about 12.21GHz to 14.4GHz, the second resonant frequency is located at about 21.41GHz, with -10dB impedance bandwidth from about 20.64GHz to 22.44GHz, and the high band resonant frequency is located at about31.67GHz, with -10dB impedance bandwidth from about 30.89GHz to 32.8GHz.**

***Keywords: Patch antenna; Multi - Band; Ku/K/Ka band ; HFSS; Array Antenna.***

## 1. Introduction

In the last two decades, many others presented numerous antenna designs are presented [1-3]. In fact, the majority of them are suitable for the application under the 10GHz. In the [4-6] some antennas for WLAN application operates in 2.4GHz band also in (5-6GHz) are proposed, also in [8-9] authors proposed structures for RFID systems, and others applications [10] are designed based on microstrip antennas. More and more patch antenna finds their way into new applications such as satellite applications.

Currently, in radar and space satellite communication application [11-12], microstrip patch antennas have great demand due to their low profile, mechanical robustness, compatible with MMIC designs, and design compact. The main goal of artificial satellites in telecommunications applications is to provide communication links between various points on earth by using antennas.

The use of different frequencies in multi system needs the use of a multiband antenna. In this paper, we are proposing the structure of a new rectangular multiband antenna array in the form of a rectangular novel. The resulting antenna has been found to possess a compact size of 20 mm x 20 mm, the antenna is an multiband antenna that resonates at the Ku(12GHz – 18GHz), K(18GHz – 27GHz) and Ka ( 27GHz – 40GHz) band.

The goal of the parametric study was carried out to optimize the design of the proposed antenna , this work presents a study about the influence of the dimensions on the antenna. The new antenna array configuration antenna design is varified by HFSS (High Frequency Structure Simulator) based on the finite element menthod(FEM).

*Nomenclature*

d length of antenna
e width of antenna
MMIC Monolithic Microwave Integrated Circuit
RFID Conventional Rectangular Microstrip Patch Antenna
WLAN Wireless Local Area Network

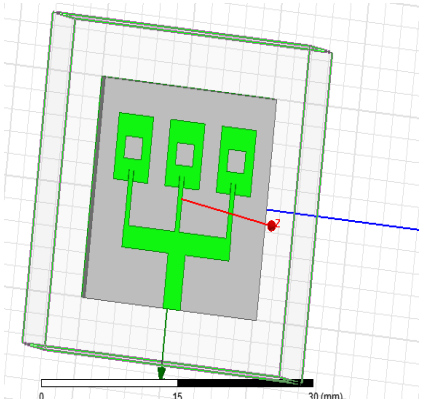
## II. Antenna description and design

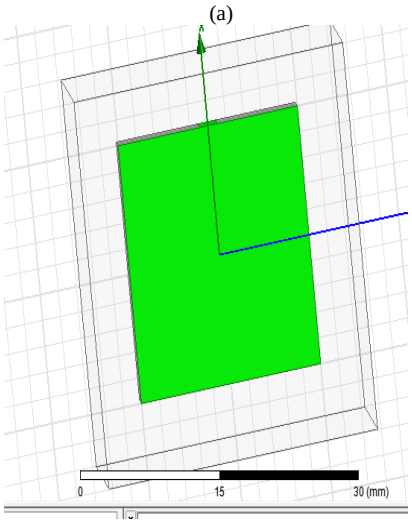
In this work, we are proposing a new rectangular structure in the form of rectangular novel, fed by a microstrip line is made with FR4 substrate, fed by a 50 microstrip line, a thickness of 1.6mm, and a relative permitivity of 4.4. The antenna is printed on a partial ground plane and suitable for Ku, K and Ka satellite applications, as illustrated in the figure 1.

Table 1. Design specifications of the proposed antenna

| Parameters | Value (mm) |
|---|---|
| Length of substrate | 20 |
| Width of substrate | 20 |
| Length of patch | 6 |
| Width of patch | 4 |
| Height of substrate | 1.6 |

The resulting multiband antenna has been found to possess a compact size of 20 mm x 20 mm as shown in the table 1, and suitable for Ku (12GHz - 18GHz), K (18GHz - 27GHz) and Ka (27GHz - 40GHz) band for : Radar, satellite communication systems, aircraft navigation, and radio astronomy applications.






(b)

Fig. 1. Proposed antenna structure

The configuration of antenna is illustrated as shown in the figure 1, which (1a) describes the structure of antenna from the top, and the figure 1b which is the down view of the proposed antenna.

The structure of the proposed antenna is stimulated using finite element method(FEM) software HFSS.

## III. Simulation and study results

The reflection coefficient (1) is a measure of how much power is reflected back at the antenna port due to mismatch from the transmission line. An S11 value measured in dB and are negative, and expressed the ratio of reflected power to incident power at port 1, if S11< -10dB then 90% of power excited is transmitted.

S11(dB)= 20xlog(Pref/Pin)

(1)

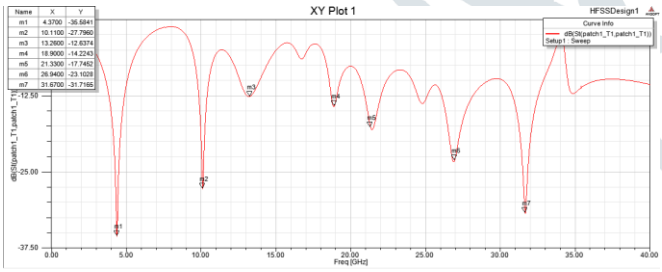



Fig. 2. Simulated return losses of the proposed antenna.

Figure 1 shows the scattering parameter S11 of the proposed antenna which contains three main bands of operation ranging from 12.21GHz to 14.4GHz for Ku band applications, from 20.64GHz to 22.44GHz for K band applications, and 30.89GHz to 32.8GHz for K band applications. The antenna can be used for satellite communications applications and the resonances occur at 13.26GHz, 21.41GHz and 31.67GHz.

The simulating result shows that the proposed design is verified by good resonance frequencies and is a multiband antenna with a very large bandwidth. The presented antenna is suitable for Ku band and has best performance.

The bandwidth and resonance frequencies of the proposed antenna can be summarized as follows:

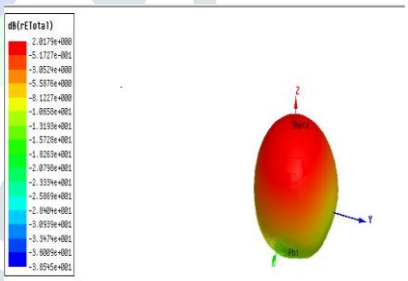
- The first bandwidth located at from 12.21GHz to14.4GHz, and resonance at 13.26GHz.
- The second bandwidth located at from 20.64GHz to 22.44GHz, and resonance at 21.41GHz.
- The third bandwidth located at from 30.89GHz to 32.8GHz, and resonance at 31.67GHz.

A parametric study was carried out to evaluate the diversity performance of the antenna. This study is very interesting because it gives unsatisfactory results before the manufacture of antenna can be made. A study of the antenna's parameters has been done which affect dimensions is presented.

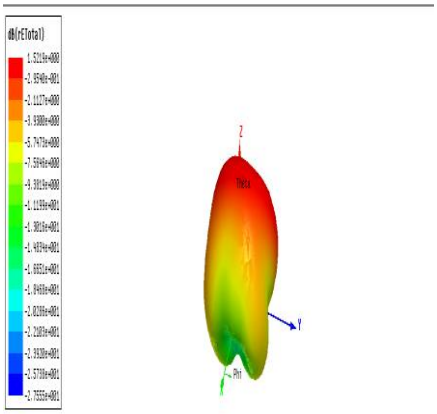
The figure 3 shows the 3D radiation pattern different resonance frequencies (3a) for 13.26GHz,(3b) for 21.41GHz and (3c) for 31.67GHz.

The proposed antenna presents almost a good gain values at the three resonance frequencies. The gain of the proposed antenna can be summarized as:

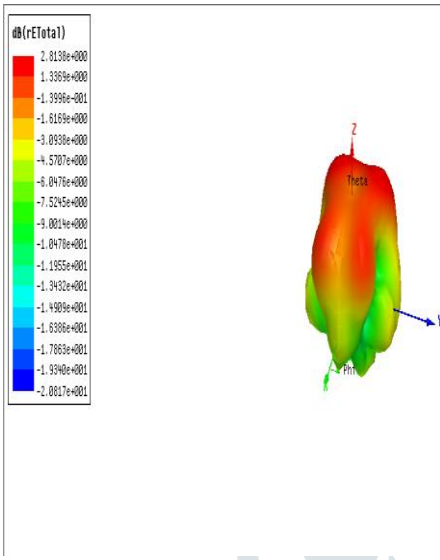
- For the first resonated frequency: 1.52dB
- For the second resonated frequency: 2.81dB
- For the third resonated frequency: 3.29dB



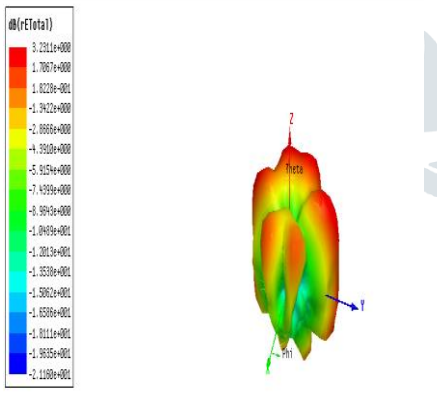

(a)




(b)




(c)




(d)

Fig 3. The radiation patterns in 3D (a) f=10GHz (b)f=13.26GHz (c)21.41GHz (d) 31.26GHz

## IV. Conclusion

In this paper, a new multiband antenna array in the form of a set of rectangular novel was presented with a compact size of 20 mm x 20mm. The final antenna structure radiates at three frequencies. The first resonant frequency is located at about

The proposed antenna presents almost a good gain values. Finally, we have shown that the presented antenna is valid for satellite communications resonate at Ku(12GHz-18GHz) band and also for K(18GHz - 27GHz) and Ka (27GHz - 40GHz) band applications.

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