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Multiple Patch Antenna System for Wireless Applications

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Abstract - *A Multiple c-shaped Microstrip patch antenna to provide a wide range of coverage is presenting in this research work. The system consists of five c shaped patch antennas and the feeding network. The feeding network is coplanar waveguide. The feeding network and radiating elements can be fabricated on FR4 dielectric substrate with thickness of 1.6mm and its relative permittivity is4.4. The geometry of proposed system is designed at 2.4GHz and it can improve the system performance by providing wide range of coverage in radiation. The system is used to provide the multiple resonance frequencies for various wireless applications like DCS, MCS, WLAN, Wi -MAX. Modelling and simulation is performed in HFSS electromagnetic simulator.*

Keywords: *Microstrip patch Antenna, Feed, Substrate.*

I. INTRODUCTION

The great success in the mobile communication industry has fostered the development of various wireless communication systems, which require complex antenna systems to achieve high quality performance. For this, the multiple antenna approach has received much attention in both antenna and wireless communications sectors. Microstrip antennas are widely used for achieving directional radiation patterns due to their low profile, light weight, low costs, and flexible structure.
The following types of antennas are used for Wireless applications,

- ✓ Wire Antennas
- ✓ Aperture Antennas
- ✓ Microstrip Antennas
- ✓ Array Antennas
- ✓ Reflector Antennas
- ✓ Lens Antennas

Among those antennas we are chosen Microstrip patch antenna for Wireless applications. Because of its compact size and low cost.

II. MICROSTRIP ANTENNA

One of the most exciting developments in antenna and electromagnetic history is the advent of Microstrip antenna (known also as patch antenna). It is probably the most versatile solution to many systems requiring planner radiating element. Microstrip antenna falls into the category of printed antennas: radiating elements that utilize printed circuit manufacturing processes to develop the feed and radiating structure. Of all the printed antennas, including dipole, slots, and tapered slots; Microstrip antenna is by far the most popular and adaptable. This is because of all its salient features including ease of fabrication, good radiation control, and low cost of production. Figure1 shows M

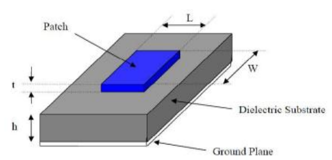

Fig.1. Rectangular Microstrip Antenna.

The Microstrip antenna is constructed from dielectric substrate and patch metal and that a portion of the metallization layer is responsible for radiation. Microstrip antenna was conceived in the 1950s, and then extensive investigations of the patch antennas followed in the 1970s and resulted in many useful design configurations. Through decades of research, it was identified that the performance and operation of a

Microstrip antenna is driven mainly by the geometry of the printed patch and the material characteristics of the substrate onto which the antenna is printed.
There are several techniques available to feed or transmit electromagnetic energy to a Microstrip antenna. The four most popular feeding methods are the
1. Coaxial probe
2. Microstrip line (edge feed and inset feed)
3. Aperture coupling
4. Proximity coupling
5. Coplanar waveguide feed

III. MULTIPLE C-PATCH ANTENNA

We are going to implement multiple C-shaped patch antenna for the Wireless applications and also overcomes the bandwidth capability of the existing system. our system has multiple frequency bands. Fig.2. shows existing C-shaped patch antenna

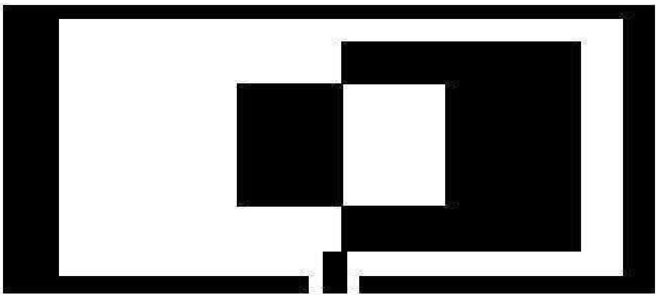

Fig.2. Existing C shaped patch antenna

To increase the bandwidth capability of the patch antennas the following Techniques are used,
a) By adjusting the length &width of antenna
b) By adjusting gap between different patches
c) By having proper dielectric substrates
d) By having different feeding techniques

VI. DESIGN OF MULTIPLE C-SHAPED ANTENNAS

1.1 Design Parameter

1.1.1 Width of the Microstrip line (w):

The transmission line characteristics impedance Z0 and relative dielectric constant εr, then the W/h ratio can be found as,

$$\frac{W}{h} = \frac{8e^{-4}}{e^{2A}-2} \; for \frac{W}{h} < 2$$

Where

$$A = \frac{Z_0}{60}\sqrt{\frac{(\varepsilon_r+1)}{2}} + \frac{\varepsilon_r-1}{\varepsilon_r+1}\left(0.23+\frac{0.11}{\varepsilon_r}\right)$$

1.1.2. EFFECTIVE DIELECTRIC CONSTANT (ε_reff)

$$\varepsilon\_reff = \frac{\varepsilon\_r+1}{2} + \frac{\varepsilon\_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$$

εr - The dielectric constant of the substrate
εreff - Effective dielectric constant
h -Height of the dielectric substrate
w -Width of the patch

1.1.3. Guided wavelength (λg):

The guided wavelength is given by

$$\lambda_g = \frac{\lambda_0}{\sqrt{\varepsilon_{reff}}}$$

where εreff is effective dielectric constant of the microstrip line and λ0 is free space wavelength in m, which is given by,

$$\lambda_0 = \frac{c}{f_r}$$

Where c is velocity of light in m/s,
fr is resonant frequency in Hz..

I. SIMULATION RESULTS

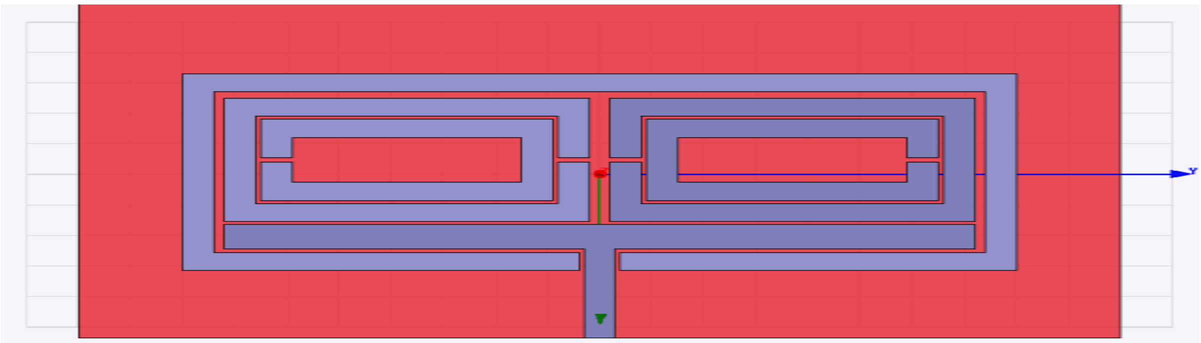

Fig.3. Proposed C-shaped Model in HFSS

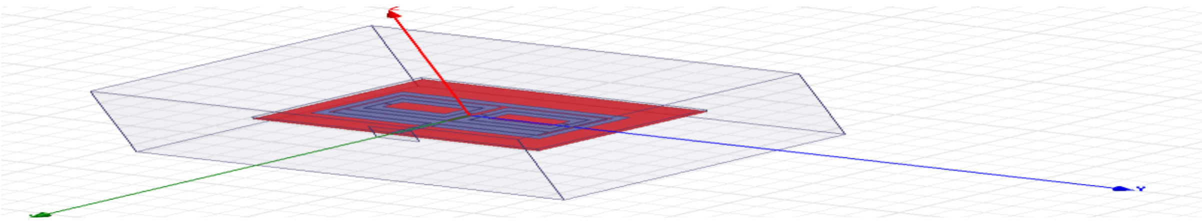

Fig.4. 3-D view of the multiple c-shaped patch antennas

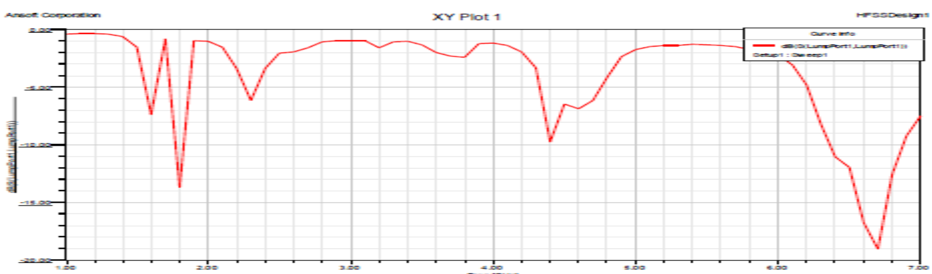

Fig.5.Frequency Response of the multiple c shaped antenna

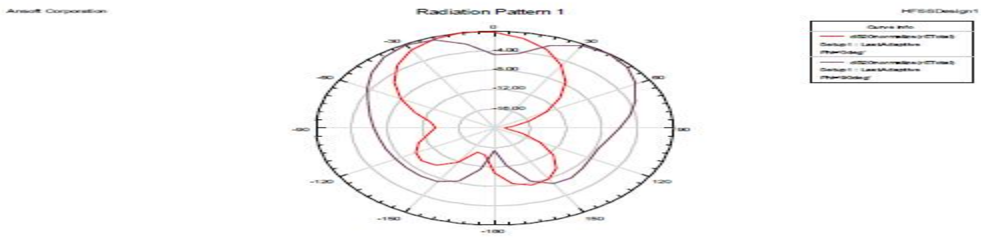

Fig.6.Radiation Pattern of Proposed C-shaped antenna

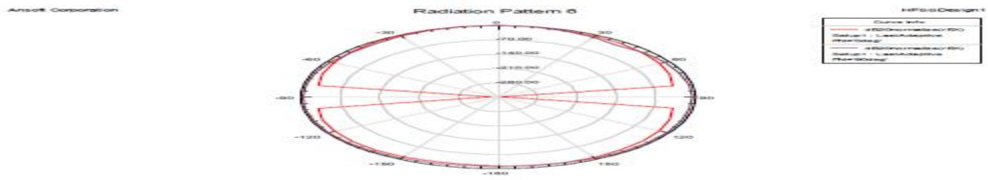

Fig.7. Radiation pattern REx at 20 db normalized

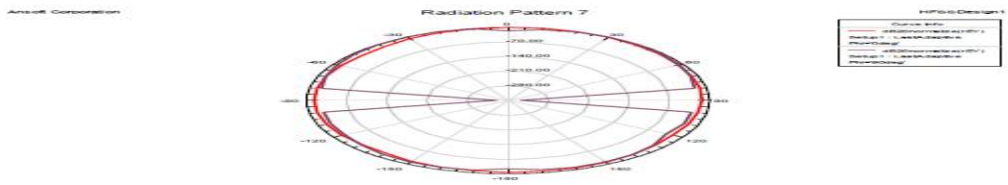

Fig.8. Radiation pattern REy at 20 db normalized

V. MATLAB CODE FOR CALCULATION

```
er=4.4;
fr=2.4*10^9;
h=1.6;
z=input('Impedance:');
a=sqrt((er+1)/2);
b=(er-1)/(er+1);
c=(.23+(.11/er));
A=((z/60)*a)+(b*c);
w=(8*exp(A)/(exp(2*A)-2))*h;
disp('Width of the patch');
disp(w);
a1=(er+1)/2;
b1=(er-1)/2;
c1=power((1+(12*(h/w))),-.5);
eeff=a1+(b1*c1);
disp('Effective dilectric constant of patch');
disp(eeff);
lamda0=(3*10^8*1000)/fr;
disp('lamda zero');
disp(lamda0);
lamdag=lamda0/sqrt(eeff);
disp('lamda g');
disp(lamdag);
```

VII CONCLUSION

Multiple c-shaped patch antenna is simulated and fabricated on FR-4 dielectric substrate where the simulated return loss is 20 dB at 6.7 Ghz, 10db at 4.4 GHz and 14db at 1.8 GHz. Thus we are getting triple frequency bands 1.7-1.9Ghz, 4.3-4.8Ghz and 6.1-7Ghz. This antenna operates under L,S & C bands of frequencies which are suitable for various applications like DECT cordless telephone , AWS mobile systems(U.S), PCS mobile phone systems ,DCS & Radars. We have the better results at 6.1-7 GHz range which has good return loss characteristics. Continue to the work we have to adjust the certain parameters to obtain better return loss characteristics of other bands & also have to increase the band efficiency to make it suitable for wide range of wireless applications .

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