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Gain Enhancement of Microstrip Patch Antenna For WLAN application using Array configration

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Abstract:- Microstrip Antenna (MSA) is a simple radiating structure fabricated on the dielectric substrate with one side radiating patch element and another side ground plane. Micro strip patch antennas are of low weight, low cost, small size compare to other antennas. The limitations of MSA are narrow band, small gain and lower power handling capacity. This paper presents various array configuration of rectangular patch element. Simulation result shows that here maximum gain is about 9.8 dBi using FR4 substrate.

Keywords:- Array, Dielectric constant, Gain, Impedance matching, Patch, Return loss.

I. INTRODUCTION

In the field of antenna, microstrip patch antenna is the most demanding area since last many years. Many researchers are doing very interesting and productive work for the design and development of MSA. During this period there have been many research papers which are being published in various journals, various presentations are being carried out in various conferences, various online articles are available, many books are published and short term training programs (STTP) are devoted to the field of MSA. As a result the evolution of microstrip patch antenna started from academic area to the commercial reality and now are being used with wide area of application and are becoming faster and faster.

In the recent years MSA are more used for commercial purpose and are more attracted for their small size, low weight, low cost, simple structure, high data rate, easy integration with monolithic microwave integrated circuits (MMICs), easy fabrication process compare to other traditional antennas. On the other side of these MSAs have some drawbacks like narrow bandwidth, feed network losses due to improper impedance matching, low power handling capacity, small gain, less efficiency etc [1].

Larger gain is always a positive benefit. High-gain antennas have the advantage of long range and better signal quality. The gain obtained from single patch antenna can be increased by using various techniques.

II. PATCH ANTENNA DESIGN STEPS

To design the patch antenna some parameters are necessary such as resonant frequency, dielectric constant, substrate height. By using formulas we are calculating the patch length, width, effective length, effective dielectric constant etc [3].

Width of metallic patch (W)

$$W = \frac{1}{2fr\sqrt{\mu o \varepsilon o}}\left(\sqrt{2}\ \sqrt{(\varepsilon r + 1)}\right) \frac{v0}{2fr} = \left(\sqrt{2}\ \sqrt{(\varepsilon r + 1)}\right) \quad \ldots (1)$$

Where, $v0$ = free space velocity of light
ε_r = Dielectric constant of substrate
εo = Dielectric constant of Air

Effective dielectric constant is calculated from Length of metallic patch (L)

$$L = L_{eff} - 2\Delta L \quad \ldots (2)$$

Where

$$Leff = \frac{1}{2fr\sqrt{\varepsilon reff}\sqrt{(\varepsilon o \mu o)}} \quad \ldots (3)$$

Calculation of Length Extension

$$\frac{\Delta L}{h} = \frac{(0.412)(\varepsilon reff + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon reff - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad \ldots (4)$$

GAIN ENHANCEMENT USING PATCH ARRAY

Microstrip patch antenna designs show lower or decreased antenna gain due to reduction in antenna size. Gain of an antenna is directly proportional to the (effective) aperture area of an antenna. A single patch antenna with one substrate and a ground plane is termed as conventional patch antenna. Gain of conventional microstrip patch antenna is about 3-4dBi [3].

Deschamps from USA and Gutton and Bassinot from France have developed the concept of micro strip patch antenna around 1953 [5]. Munson developed low profile microstrip antenna which used on rocket and missiles and proved that microstrip patch antenna is a very useful practical concept in this new era of communication [8]. Many researchers are working in the area of patch antenna for its gain improvements using various different methods.

DESIGN I. SINGLE PATCH

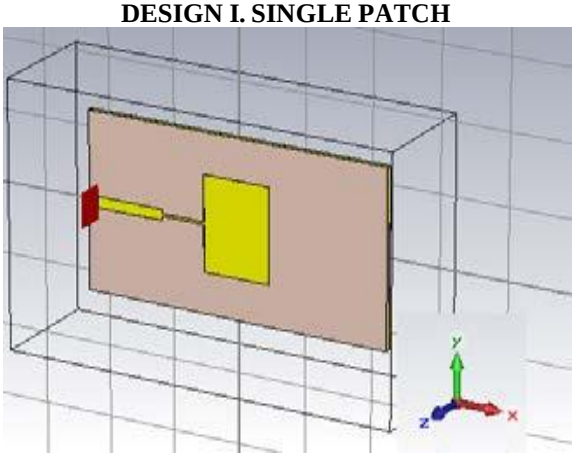


Figure 1 Single patch antenna

Dimensions of Patch, Substrate and Ground plane are as listed below:

Length of Patch = 19.75 mm Width of Patch = 26.85 mm Height of Substrate = 1.6 mm
Length of Substrate and Ground = 90 mm
Width of Substrate and Ground = 50 mm

S11 parameter:

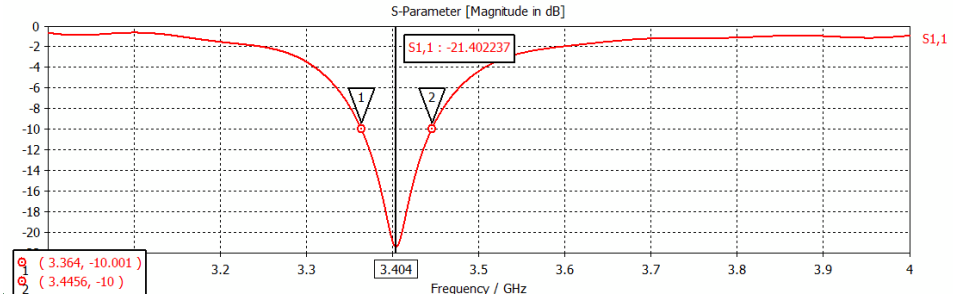
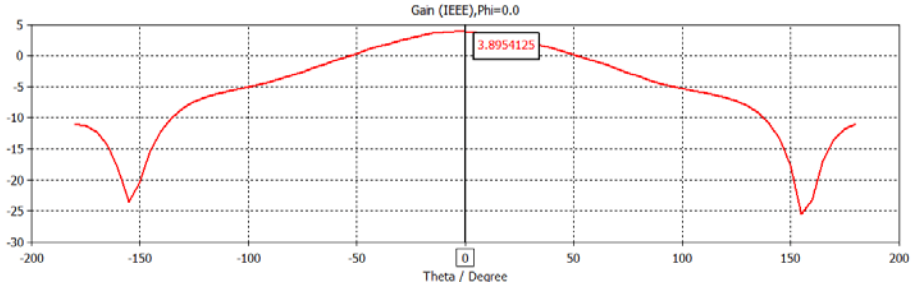


Figure 2 S11 parameter for single patch

S11 = -21.40 dB

Gain:

Gain obtained from inset feed single patch antenna is 3.89 dBi. This gain can be increased by increasing number of patch element by making array form.



Gain = 3.89 dBi

Figure 3 Gain of single patch

DESIGN II. 1 X 2 PATCH ARRAY

Dimensions of Patch, Substrate and Ground plane are as listed below:

Length of Patch = 19.2 mm Width of Patch = 30 mm Height of Substrate = 1.6 mm
Length of Substrate and Ground = 65 mm
Width of Substrate and Ground = 95 mm

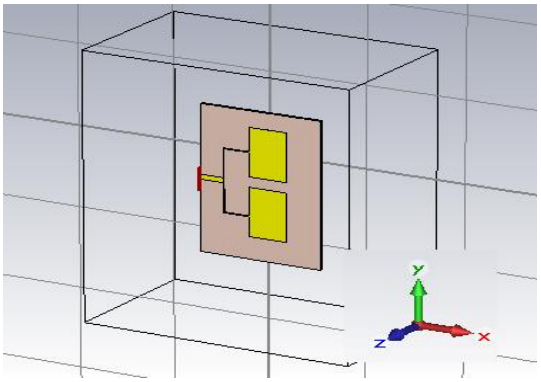


Figure 4 1 x 2 patch array

S11 parameter:

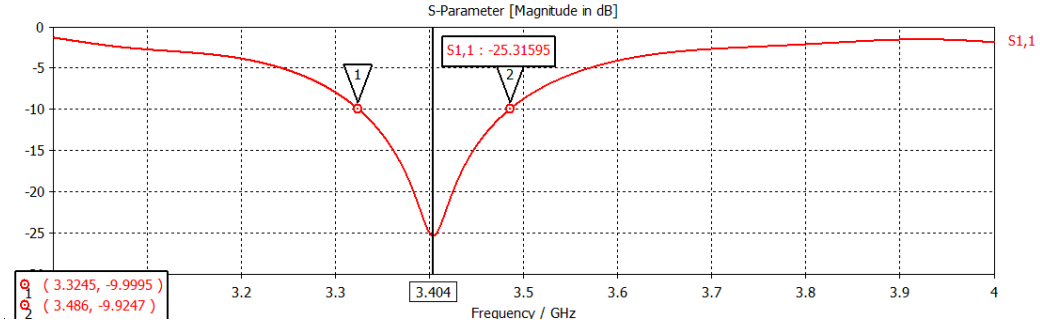


Figure 5 S11 parameter for 1 x 2 array

S11 = -25.31 dB

Gain:

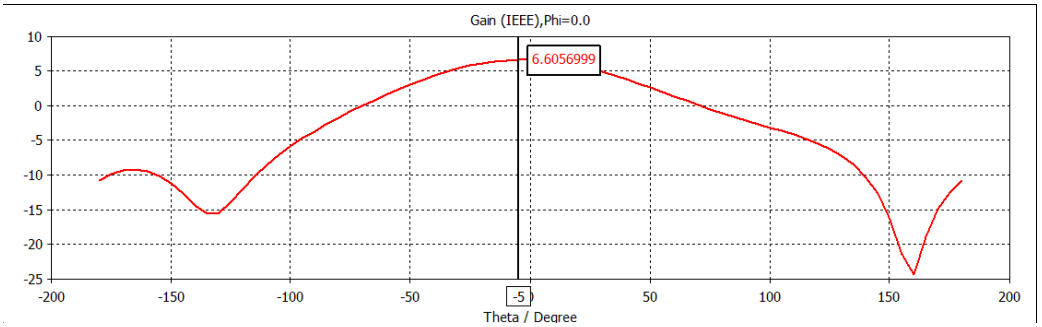


Figure 6 Gain of 1 x 2 patch array

Gain = 6.06 dBi

Here from the results of 2 x 1 patch array for 3.4 GHz application and it is observed that Gain increases up to 2.7 dBi compare to single patch antenna.

DESIGN III. 1 X 4 PATCH ARRAY

Dimensions of Patch, Substrate and Ground plane are as listed below:

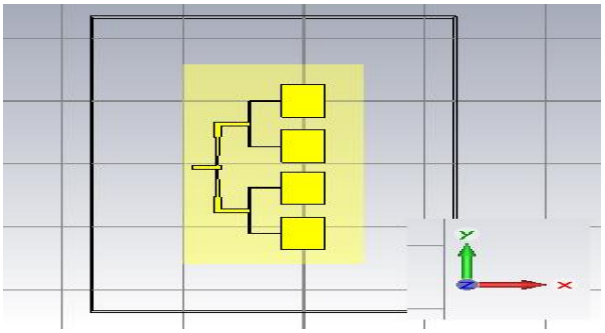


Figure 7 1 x 4 patch array

Length of Patch = 17.8 mm
Width of Patch = 26 mm
Height of Substrate = 1.6 mm
Length of Substrate and Ground = 100 mm
Width of Substrate and Ground = 160 mm

S11 parameter:

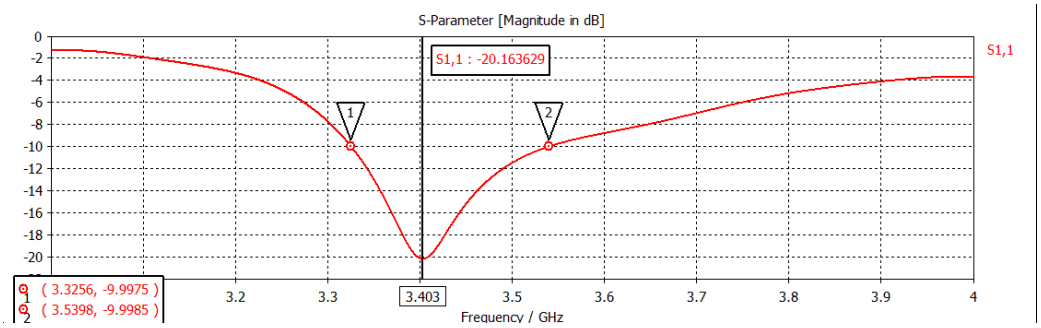


Figure 8 S11 parameter for 1 x 4 array

S11 = -20.16 dB

Gain:

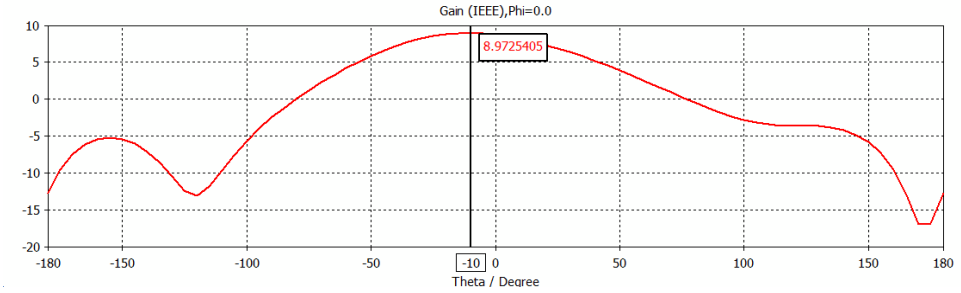


Figure 9 Gain of 1 x 4 patch array

Gain = 8.97 dBi

Here simulation results shows for 1 x 4 patch array that the gain further increases up to 2 – 2.3 dBi. Additional benefit of this design is that the bandwidth is also increased.

DESIGN IV. 1 X 8 PATCH ARRAY

Dimensions of Patch, Substrate and Ground plane are as listed below:

Length of Patch = 17.8 mm Width of Patch = 28 mm Height of Substrate = 1.6 mm

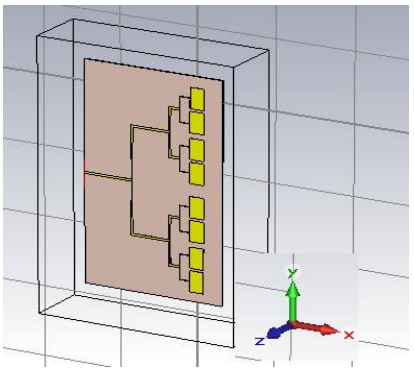


Figure 10 1 x 8 patch array

Length of Substrate and Ground = 180 mm
Width of Substrate and Ground = 315 mm

S11 parameter:

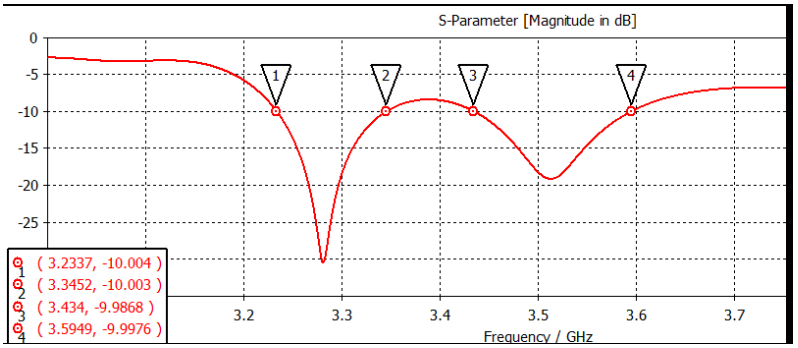
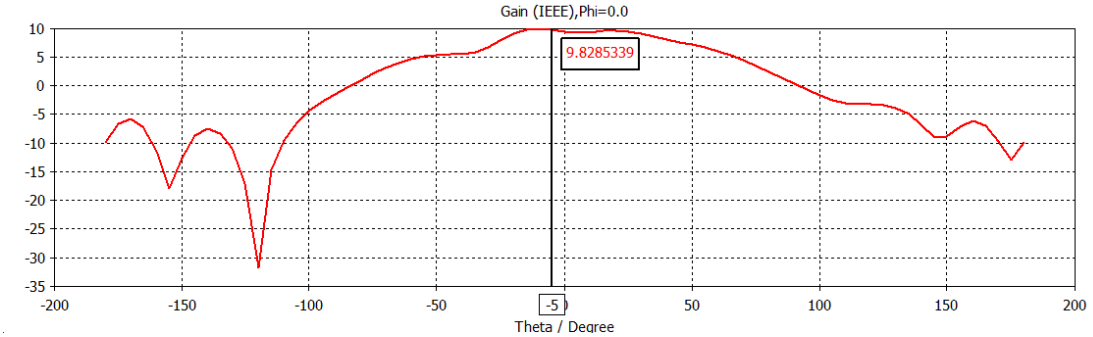


Figure 11 S11 parameter for 1 x 8 array

S11 = -30.01 dB

Gain:



Gain = 9.82 dBi

Figure 12 Gain of 1 x 8 patch array

Here simulation results shows for 1 x 8 patch array that the gain further increases up to 1 dBi.

V. CONCLUSION

Gain of an antenna is responsible for good signal strength and large coverage area. This paper describes patch array configuration to increase gain of patch antenna. As number of patch element increases effective aperture area increases. This results in improvement of gain. Maximum gain here is achieved is about 9.82 dBi for 1 x 8 patch array configuration using FR4 substrate.

REFERENCES

[1]. R.Garg, Microstrip Antenna Design Handbook, Artech House Boston, 2010
[2]. Compact and Broadband Microstrip Antennas. Kin-Lu Wong, John Wiley & Sons, Inc. 2002 [3] C. A. Balanis, Antenna Theory, Willey Inter science, 3rd Edition, 2014.
[3]. Micro Strip Antennas by D M Pozar. John Wiley & Sons, 1995.
[4]. Carver, Mink "Microstrip Antenna Technology" IEEE Transactions on Antennas and Propagation No. 1, January 1981.
[5]. Bahadir Yildirim and Bedri A. Cetiner "Enhanced Gain Patch Antenna With a Rectangular Loop
[6]. Shaped Parasitic Radiator" IEEE Antennas And Wireless Propagation Letters, 2008.
[7]. Sudipta Chattopadhyay, Jawad Siddiqui and Debatosh Guha "Rectangular Microstrip Patch on a Composite Dielectric Substrate for High-Gain Wide-Beam Radiation Patterns" IEEE Transactions on Antennas and Propagation October 2009.
[8]. Mohit Joshi, Parth Bhasker " Gain Enhancement Methods for Microstrip Patch Antenna " International Journal of Futuristic Trends in Engineering & Research Vol. II (II), 2015