Design & Analysis of Microstrip Patch Antenna at 9 GHz

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Abstract- The wireless communication demands the antenna with properties like compact, broadband, multiple resonant frequencies. The microstrip patch antenna satisfies most of these demands. In this paper the design & analysis of microstrip rectangular antenna at 9GHz is presented using HFSS-13 Software. The resulting SWR is less than-10dB for 13GHZ-19GHz frequencies. The resulting VSWR is less than 2 dB for 13-19GHz.

Keywords – microstrip rectangular patch antenna, VSWR, SWR,

I. INTRODUCTION

The microstrip patch antenna consists of very thin (thickness << 10^{-6}wavelength) metallic strip (called patch) placed on a low loss dielectric slab (called substrate) of height h<<10^{-3} wavelength above a ground plane .It is designed to have its pattern maximum normal to the patch. The microstrip antenna operate at frequency range from 100 MHz -100GHz. Next generation wireless communication aim is high speed networking service for multimedia communication using the frequency band 5.470 -5.725 GHz with Omni directional antenna .These demand design of reduced size & moderate gain multifrequency antenna for wireless terminals .Thus in applications requiring small size , low weight & cost , performance & ease of installation microstrip antennae are required. For example high performance aircraft, spacecraft, satellite & missile applications. The advantages of patch antenna are Low profile , low weight , small size , simple & inexpensive ,conformable to planar & non planar surfaces ,mechanically robust ,compatible with MMIC designs ,linear & circular polarization are possible with simple feed ,dual frequency & dual polarization antennae can be made ,feed lines & impedance matching network can be integrated . The disadvantages are low power handling capability, narrow bandwidth due to tuned elements, and large size at VHF & UHF bands. The feeing methods are Microstrip line feed, Coaxial line feed, Aperture coupling feed, Proximity coupling feed.

In coaxial line feeds, the inner conductor of the coax penetrates the substrate from the back of ground plane without any contact with the ground plane and is attached to the radiation patch while the outer conductor is connected to ground plane. The coaxial line feed possess properties such as easy to fabricate, impedance matching is simple by controlling feed position ,spurious radiation is low(nearly 30 dB),bandwidth is narrow(1-3%) , it is more difficult to medel for substrate thickness>1/50 of free space wavelength . The coaxial feed is given at the center of the patch.

The most popular methods of analysis for microstrip antenna are Transmission line model, Cavity model&Full wave/ moment method. The objective is to theoretically predict the radiation characteristics i.e. radiation patterns, gain, polarization, input impedance, bandwidth & efficiency. The Transmission line model is easiest but less accurate. Cavity model is more accurate but more complex. Full wave/ moment method is most accurate but most complex

II. DESIGNING RECTANGULAR PATCH ANTENNA USING TRANSMISSION LINE MODEL

parameter	value
ϵ_r of substrate	4.4(FR4)
Height of substrate	3.2mm
f_r of antenna	9 GHz
Width of patch	10.14mm
Length of patch	7.2mm

Microstrip patch antenna

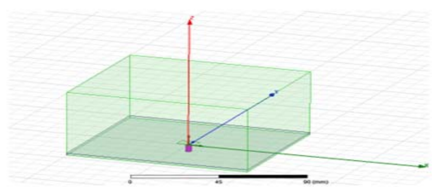

FIG. 1 Micro strip Patch Antenna

This is the picture of micro strip rectangular patch antenna designed using HFSS-13 Software.

Radiation pattern for gain

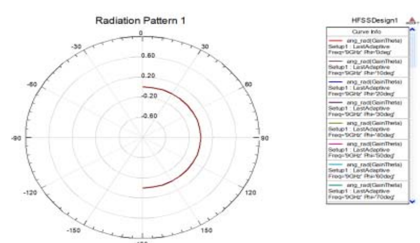

FIG. 2 Radiation Pattern

Thus, from above figure it is clear that gain is coming as 0 dB.

In radio engineering and telecommunications, standing wave ratio (SWR) is a measure of impedance matching of loads to the characteristic impedance of a transmission line or waveguide. Impedance mismatches result in standing waves along the transmission line, and SWR is defined as the ratio of the partial standing wave's amplitude at an antinode (maximum) to the amplitude at a node (minimum) along the line. VSWR (Voltage Standing Wave Ratio), is a measure of how efficiently radio-frequency power is transmitted from a power source, through a transmission line, into a load (for example, from a power amplifier through a transmission line, to an antenna for private communications.

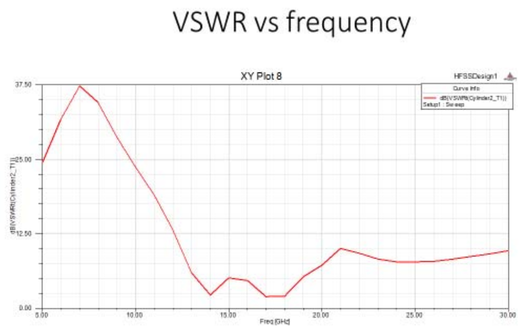

FIG. 3 VSWR Vs Frequency

Thus from the above figure the VSWR is coming near to 2.4 Db for the frequency range 13-19GHz. Also the SWR from the figure below is coming below -10dB for the frequency range from 13-19GHz. However at 9GHz appropriate results are not coming

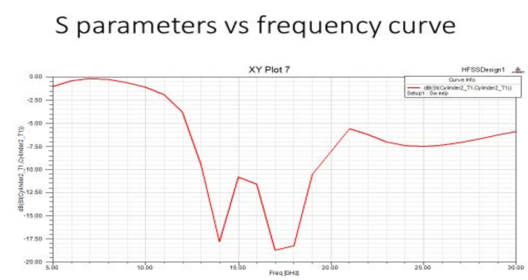

FIG. 4 SWR Vs Frequency

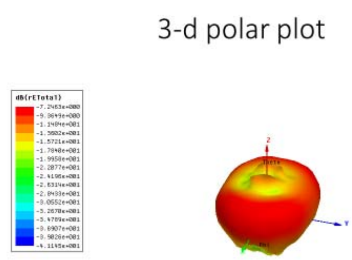

FIG. 5 3-D Polar Plot

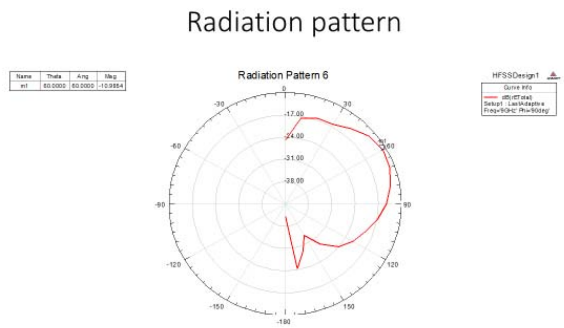

FIG. 6 Radiation Pattern

III. RESULT

The SWR is less than -10dB for 13-19GHz. The VSWR is less than 2dB for 13-19GHz. However the SWR at 9 GHz is -0.5dB & VSWR is 33dB. The gain is 0dB.

Therefore the resultant antenna is a multifrequency antenna ranging from 13-19 GHz.

IV.CONCLUSION

The microstrip rectangular patch antenna was designed for 9GHz however after analysis it resulted in an multifrequency antenna ranging from 13-19GHz .Thus, this antenna can be used in wireless communication with bandwidth 6 GHz. It is relatively easy to print an array of patches on a single (large) substrate using lithographic techniques. Patch arrays can provide much higher gains than a single patch at little additional cost; matching and phase adjustment can be performed with printed microstrip feed structures, again in the same operations that form the radiating patches. The ability to create high gain arrays in a low-profile antenna is one reason that patch arrays are common on airplanes and in other military applications.

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