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Performance Analysis of Hybrid Microstrip Patch Antenna at K_a-Band

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Abstract: In wireless communication system antenna plays vital role. Therefore, the need for antenna used in any communication system should be low weight, low profile, low cost, smaller in dimension and conformity. A microstrip patch antenna fulfills all these requirements. This paper presents design of hybrid microstrip patch antenna array operating at K_a-band. The hybrid microstrip patch antenna consists of a triangular patch mounted on a rectangular patch. The signals from the antennas are combined or processed in order to achieve improved performance over that of a single antenna. The antenna is tuned at resonance frequency of 28 GHz and its bandwidth is from 26.5 GHz to 40GHz. This technique is used to analyze the performance of 'HYBRID PATCH ANTENNA ARRAY' using different feeding techniques like microstrip and coaxial feeding techniques by using HFSS software.

Keywords: K_a-band, hybrid microstrip patch antenna, microstrip feed, coaxial feed.

I. INTRODUCTION

Antenna is a transducer which converts guided electromagnetic wave (EM) into free space electromagnetic waves and it is one of the fundamental parts of modern wireless communication networks. In this design we are using antenna array. Antenna arrays are becoming increasingly important in wireless communications. An antenna array is a multiple antenna in one antenna is antenna array. Lower gain can be overcome by arranging multiple antenna elements in antenna array. Antenna array have so many advantages are ease of manufacturing, low fabrication cost. Patches have many different shapes like circle, triangle, etc. we are using combination of two different patches like as triangular patch mounted on a rectangular patch. Its look like pentagon shaped patch. Pentagonal microstrip patch gives better performance than the rectangular patch antenna. It also supports both linear and circular polarization.

Pentagon shaped patch gives better performance than other shapes. It is operated in the frequency range is 28GHZ. This frequency has so many applications are signal attenuation at K_a-band during heavy rainfall can be up to 4or5 times that of K_U-band, antenna wetting alone 2.7 to 3.9dB of link losses at K_a-band .And also K_a-band should give you more digital bandwidth than K_u-band which in turn should give greater bandwidth than L-band. There are different types of feeds. In this technique we are using two types of feeds are microstrip feed and coaxial feeds. Using these feeds to analyze the gain parameters.

II. ANTENNA DESIGN

The satellite communication system uses the K_a -band with frequency range from 26.5 - 40 GHz. Hence the antenna designed must be able to operate in this frequency range. The operating frequency selected for the design is 28GHz. And the dielectric material is FR4 which has a dielectric constant of 4.4. The side of the triangle is t= 3.405mm. is calculated by the formulae for triangle

$$f_r = \frac{2c}{3a\sqrt{\xi_{eff}}}$$

$$\xi_{eff} = 0.5(\xi_r + 1) + 0.25\frac{\xi_r - 1}{\sqrt{1 + \frac{12h}{a}}}$$

And parameters of the rectangle are
Length of the rectangle is l= 2.9mm
Width of the rectangle is w= 1.4mm
Substrate length $= c/f\sqrt{\xi r}$
Substrate height$= 0.3c/2\pi\sqrt{\xi r}$
Patch length$= v_0/(2f_r\sqrt{(\xi_reff)}) - 2\Delta l$
Patch Width $= \frac{v_0}{2f_r}\sqrt{\frac{2}{\xi_r + 1}}$

$$\xi_{eff} = 0.5(\xi_r + 1) + 0.5\frac{\xi_r - 1}{\sqrt{1 + \frac{12h}{w}}}$$

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The Hybrid patch antenna designed using coaxial feed is shown below.

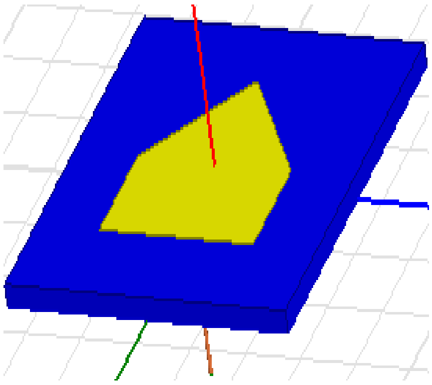

Fig 1: Hybrid patch using coaxial feed.

Results and Analysis: For this Hybrid patch antenna using coax feed, the Return loss of -36.6dB is obtained at 28GHZ

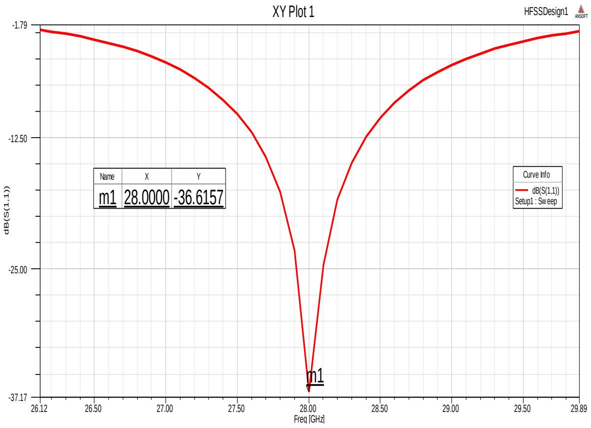

Fig 2: Return loss for Hybrid patch antenna using coaxial feed

The VSWR of 0.2565dB is obtained at 28 GHZ. 3D-Polar Plot and Radiation Pattern: The total gain of 4.1702 dB is observed from 3D-polar plot as shown in figure.

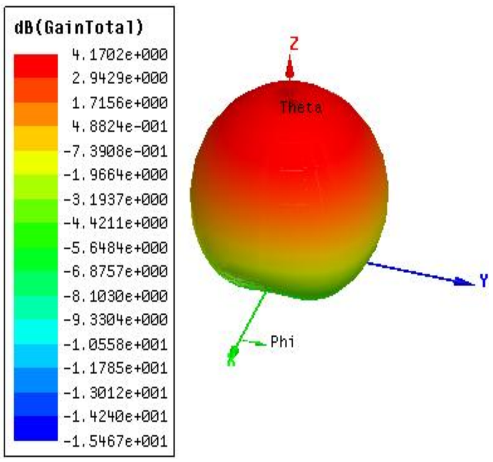

Fig 3: 3D-Polar plot for Hybrid patch antenna using coaxial feed

The Hybrid patch antenna designed using microstrip feed is shown below.

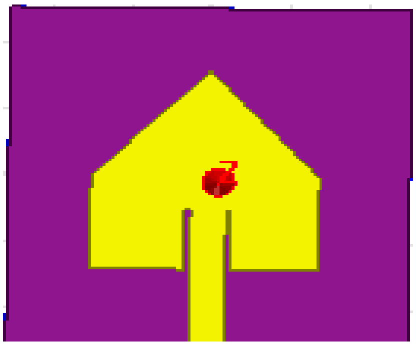

Fig 4: Hybrid patch using microstrip feed.

Results and Analysis: For this Hybrid patch antenna using microstrip feed, the Return loss of -32.8dB is obtained at 28GHZ

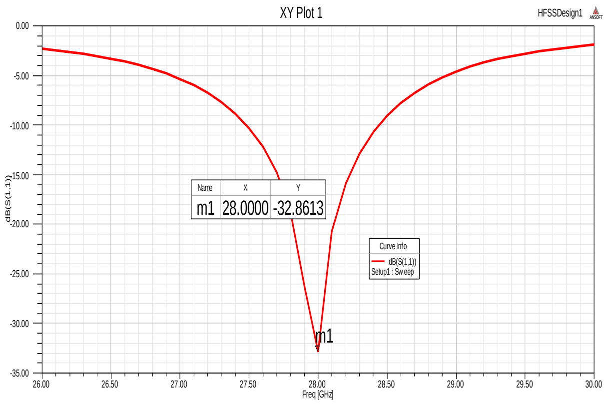

Fig 5: Return loss for Hybrid patch antenna using microstrip feed

The VSWR of 0.3952dB is obtained at 28 GHZ. 3D-Polar Plot and Radiation pattern: The total gain of 3.5980dB is observed from 3D-polar plot as shown in figure.

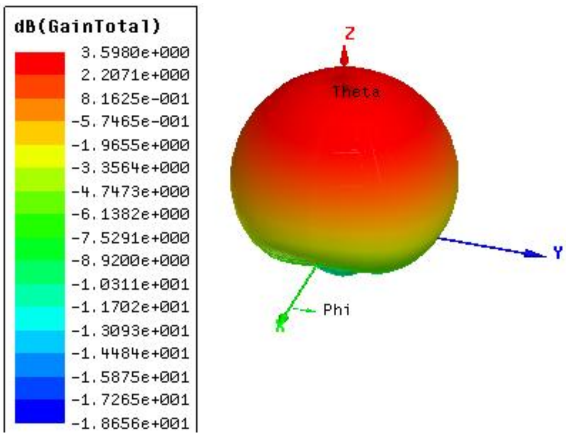

Fig 6: 3D-Polar plot for Hybrid patch antenna using microstrip feed

A four element Hybrid patch antenna array using coaxial feed is shown below

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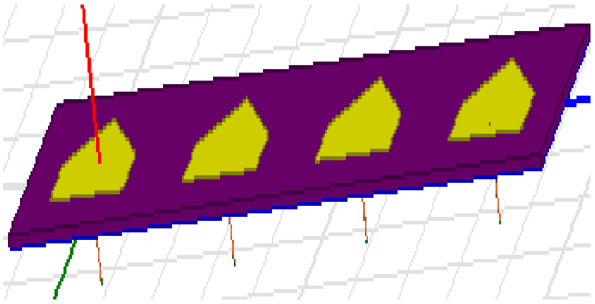

Fig 7: Hybrid patch antenna array using coaxial feed.

Results and Analysis: For this Hybrid patch antenna array using microstrip feed, the Return loss of -42.2832dB is obtained at 28GHZ

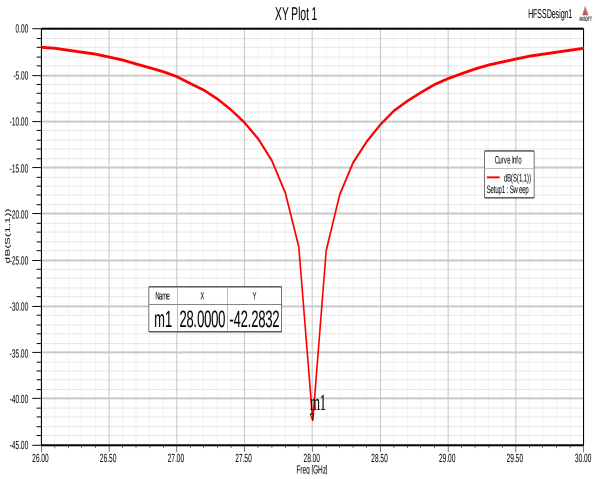

Fig 8: Return loss for Hybrid patch antenna array using coaxial feed

The VSWR of 0.133dB is obtained at 28 GHZ.

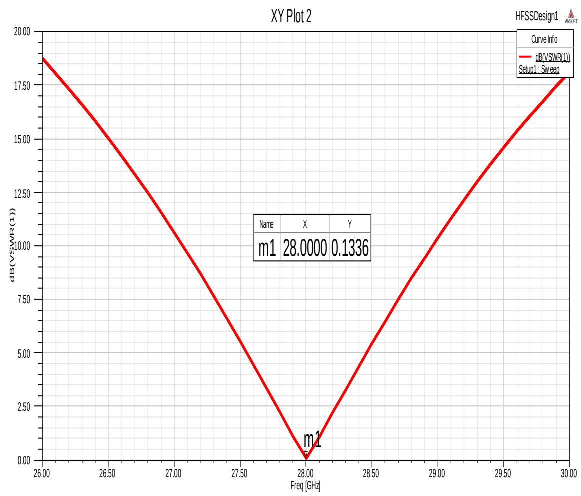

Fig 9: VSWR for Hybrid patch antenna array using coaxial feed

3D-Polar Plot and Radiation Pattern: The total gain of 9.3808 dB is observed from 3D-polar plot as shown in figure. The simulate radiation pattern of the antenna at 28GHz is shown

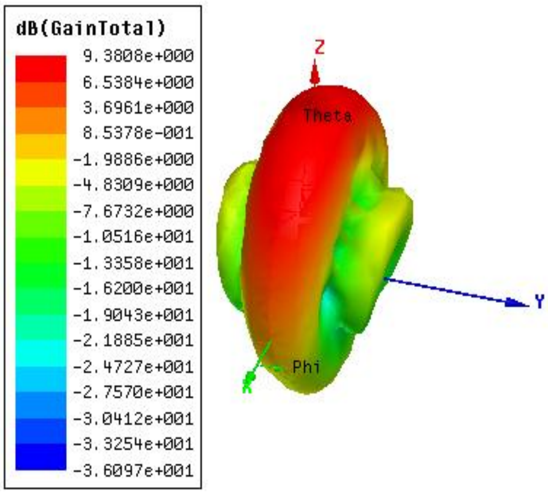

Fig 10: 3D-Polar plot for Hybrid patch antenna array using coaxial feed

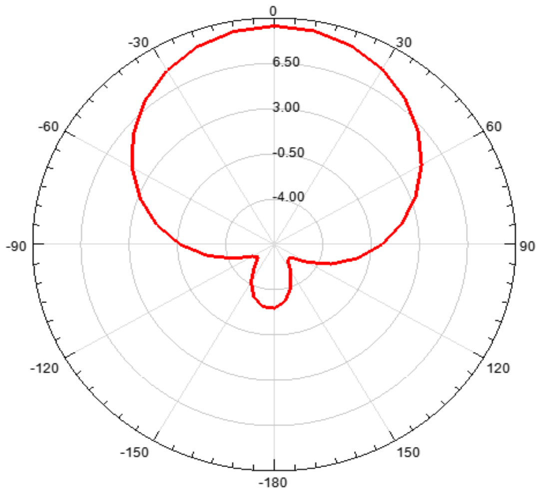

Fig 11: Radiation pattern for Hybrid patch antenna using coaxial feed

A four element Hybrid patch antenna array using microstrip feed is shown below

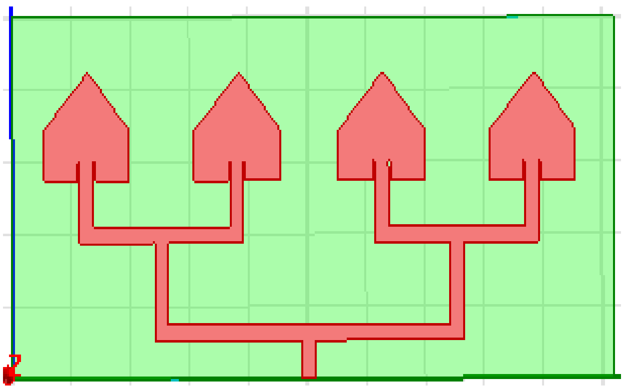

Fig 12: Hybrid patch antenna array using microstrip feed.

Results and Analysis: For this Hybrid patch antenna array using microstrip feed, the Return loss of -22.258dB is obtained at 28GHZ

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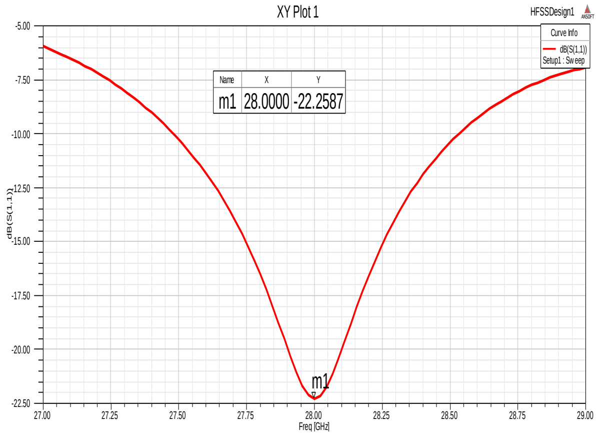

Fig 13: Return loss for Hybrid patch antenna array using microstrip feed

The VSWR of 1.3412dB is obtained at 28 GHZ.

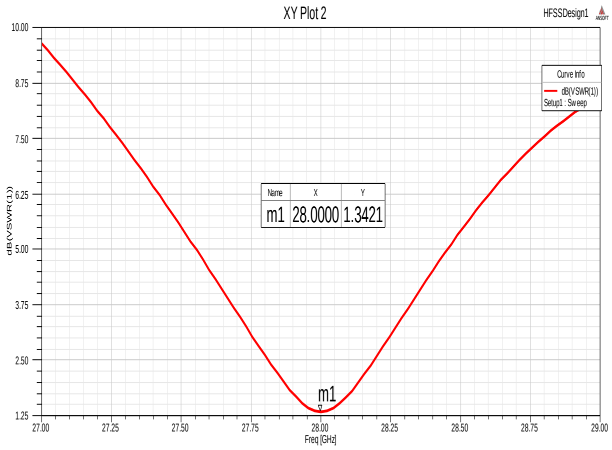

Fig 14: VSWR for Hybrid patch antenna array using microstrip feed

3D-Polar Plot and Radiation Pattern: The total gain of 8.0132 dB is observed from 3D-polar plot as shown in figure. The simulate radiation pattern of the antenna at 28GHz is shown

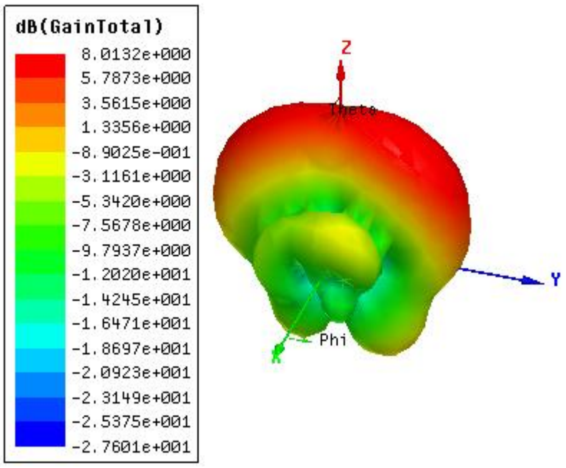

Fig 15: 3D-Polar plot for Hybrid patch antenna array using microstrip feed

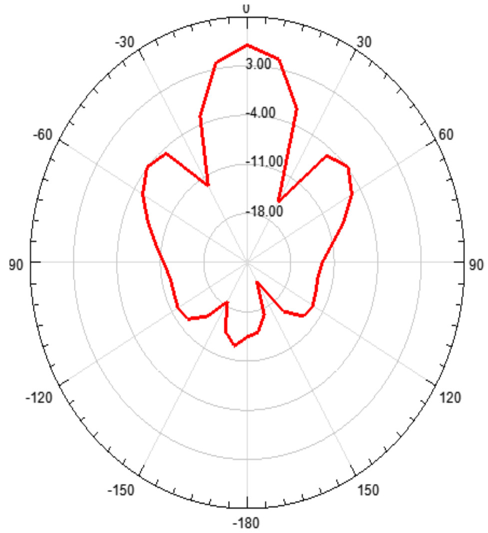

Fig 16: Radiation pattern for Hybrid patch antenna using coaxial feed

To compare the single and four element Hybrid microstrip patch antenna array using two different feeds such as microstrip or line feed and coaxial feeds at k_a band. In this we compare Return loss, VSWR, and Gain. All these are vary from microstrip and coaxial feeds and also single element and four elements are shown in table 1.

TABLE I : COMPARISON OF COAX AND MICROSTRIP FEED

Type of feed	Coax		Microstrip	
Number of elements	1	4	1	4
Freq.(GHz)	28	28	28	28
Return loss(dB)	-36.6	-42.28	-32.8	-22.2 58
VSWR (dB)	0.2565	0.133	0.395	1.3412
Gain (dB)	4.1702	9.3808	3.598	8.0132

III. CONCLUSION

In this design, the combination of triangle and rectangular patches. We are comparing various parameters like return loss, VSWR, gain and directivity of both microstrip and coax feed using Hybrid patch antenna array for Ka band using the HFSS software. In future we are using another feeds in the same frequency.

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BIOGRAPHY

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