

DESIGN OF 4 ELEMENT PLUS SHAPED SLOTTED MICROSTRIP ARRAY ANTENNAS FOR SATELLITE APPLICATION

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Abstract - Microstrip patch antenna plays an important role in wireless communication devices, radar systems, satellite communication systems and military surveillances. To improve the performance of microstrip antenna in terms of gain, directivity, efficiency and bandwidth, the microstrip patch array antennas are used. In this paper, 4 element plus shaped slotted array antenna with Series Corporate and Corporate-Series feeding techniques is proposed. The 4 element array antennas are designed in HFSS software using FR4 substrate. The 4x1 series feed antenna design is resonated at 8.28GHz frequency, 4x1 corporate feed array antenna is resonated at 8.28 GHz frequency and 2x2 corporate series feed array antenna is resonated at 8.32GHz frequency. These antennas are suitable for Satellite applications (8.1-8.35GHz).

Keywords – 4 element antennas, Slotted antennas, Array antennas

I. INTRODUCTION

Antennas are basic components of all communication systems and are used to radiate/receive electromagnetic energy. Microstrip antennas have extensive applications in wireless communication system because they have low profile, low cost and ease of fabrication but the patch antenna offers very narrow bandwidth, low gain and directivity [1]. Higher values of the antenna gain cannot be achieved with a single element. An antenna arrays are used in order to get high gain. Antenna array is the periodic arrangement of the similar type of conducting elements. All the elements in the array are isolated physically but there are connected electrically due to the fields associated in between them. In any array system, the total field pattern is always the algebraic sum of the patterns produced by each element [2].

There are several ways to design array antennas. In [3] a 4x1 square microstrip patch antenna is designed for wireless applications using series feed. In [4] comparison of 2x1 and 4x1 series feed and parallel feed array antenna is proposed, in this paper the conducting patch and ground plane are made of copper material. A 2x2 corporate-series

fed microstrip antenna array is designed for 10GHz and compared antenna array characteristics before and after optimization [5].

A directive Microstrip Patch Array Antennas with Series, Corporate and Series-Corporate Feed Network is designed using of RT-DURROID substrate, this design operates at a frequency of 10 GHz [6]. A 4x1 corporate feed circular polarized rectangular microstrip patch antenna is designed for S-band applications and compared single patch, double patch and four patches performance [7]. In [8] a 2x2 array antenna used circular ring shaped slot on antenna elements in order to get broad band and circular polarization operation. In [9] series feed and parallel methods are used for designing array antenna for C-band applications. Gain enhancement antenna is described in [10], compared slot performance with a regular antenna structure. In [11], the patch array antenna performance interns of radiation pattern are improved by using taper structure.

In this paper 4 element plus shape slotted array antenna using three feeding techniques Series,Corporate,Corporate-Series are designed.All these antennas resonated at X band frequency range and are applicable for satellite applications.Comparision of three designs are done with respect to parameters like return loss,VSWR,gain and impedance.

II. ANTENNA DESIGN

A. Series Feed Array Antenna

A series feed microstrip array is formed by interconnecting all the elements with high impedance transmission line and feeding the power at the first element.

The design of Series Feed Array Antenna is shown in figure 1 and its dimensions are shown in Table.1. Return loss plot of Series feed array antenna is shown in figure 2. It is resonating at a frequency of 8.28GHz with a return loss of -14.71dB. VSWR plot of Series feed array antenna is shown in figure 3. At resonating frequency 8.28GHz, VSWR value is 1.45.Gain plot of Series feed array antenna is shown in figure 4.The gain for 4 element series feed array antenna is 9.32dB.

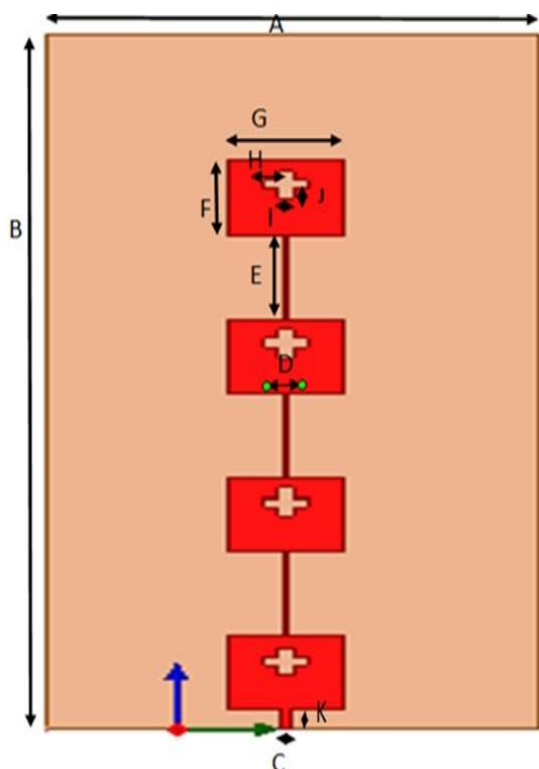


Fig.1: 4 element series feed antenna with +slot

Table 1: Parameters to design series feed array antenna

Parameter	Value
A	34mm
B	75mm
C	0.5mm
D	0.06mm
E	9.14mm
F	8mm
G	8mm
H	1mm
I	1mm
J	1mm
K	2mm

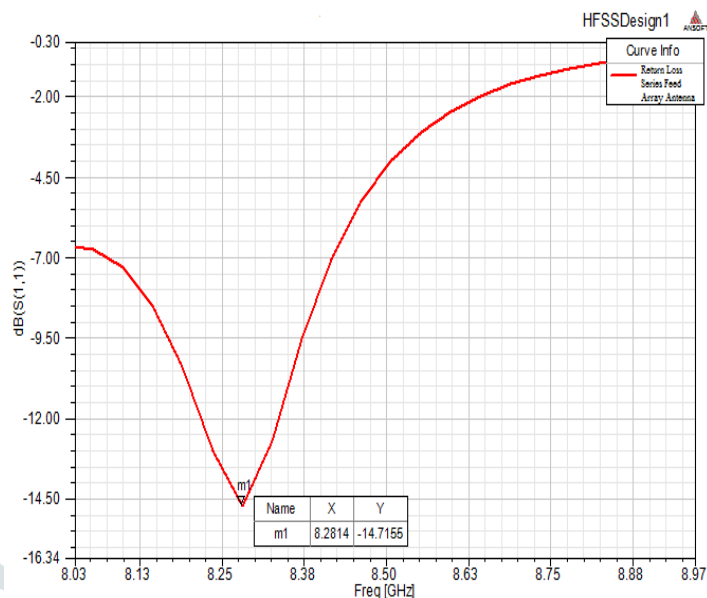


Fig.2: return loss plot of series feed array antenna

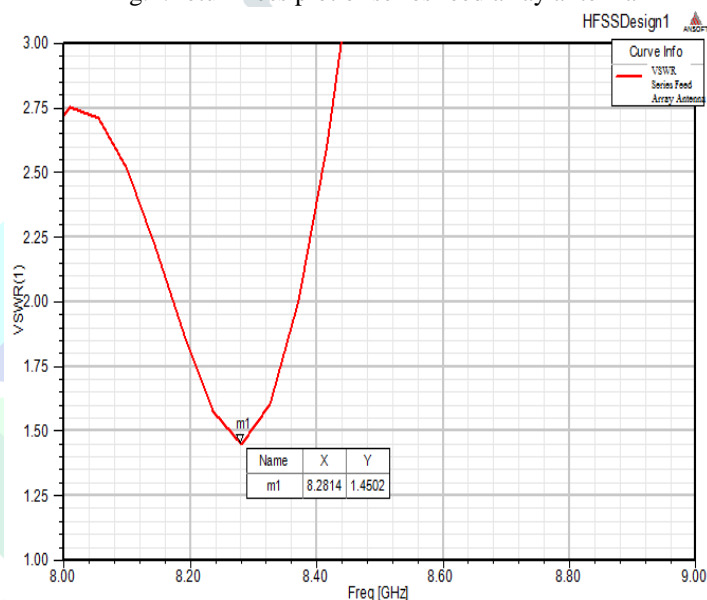


Fig.3: VSWR plot of series feed array antenna

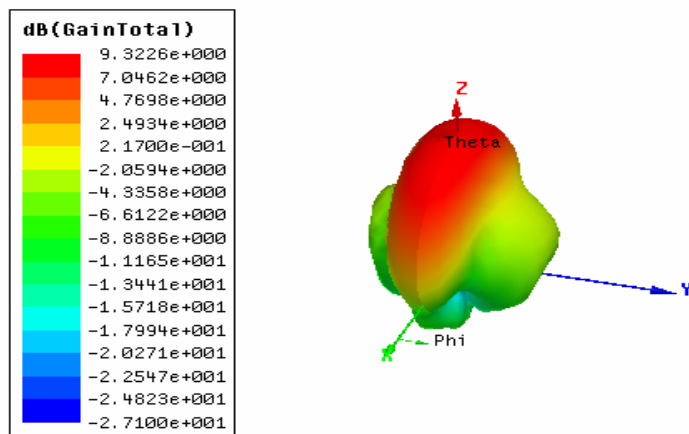


Fig.4: gain plot of series feed array antenna

B. CORPORATE FEED ARRAY ANTENNA

In this antenna elements are fed by 1:n power divider networks with identical path lengths from feed point to each element. Corporate feed arrays are general and versatile. The design of Corporate Feed Array Antenna is shown in figure 5 and its dimensions are shown in Table.2.

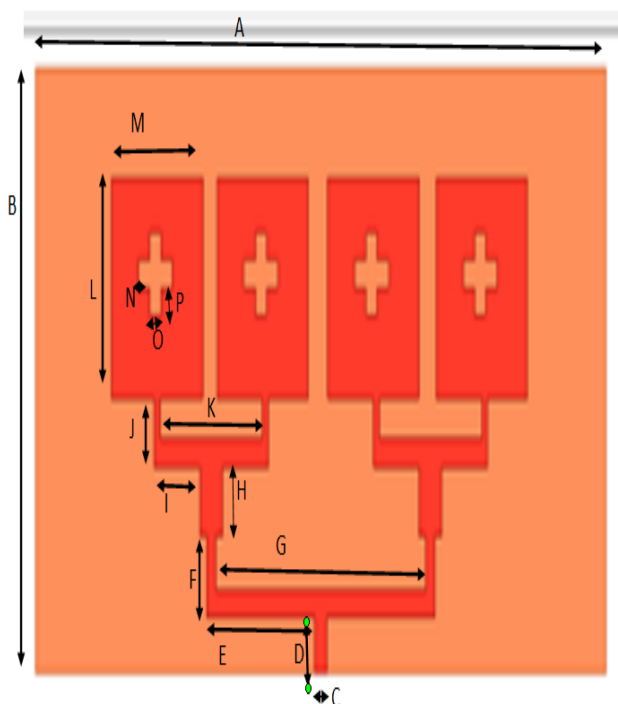


Fig.5: 4 element corporate feed antenna with +slot

Return loss plot of Corporate feed array antenna is shown in figure 6. It is resonating at a frequency of 8.28GHz with a return loss of -13.21dB. VSWR plot of corporate feed array antenna is shown in figure 7. At resonating frequency 8.28GHz, 1.55 VSWR and 8.26dB gain. 3D Gain plot of Corporate feed array antenna is shown in figure 8.

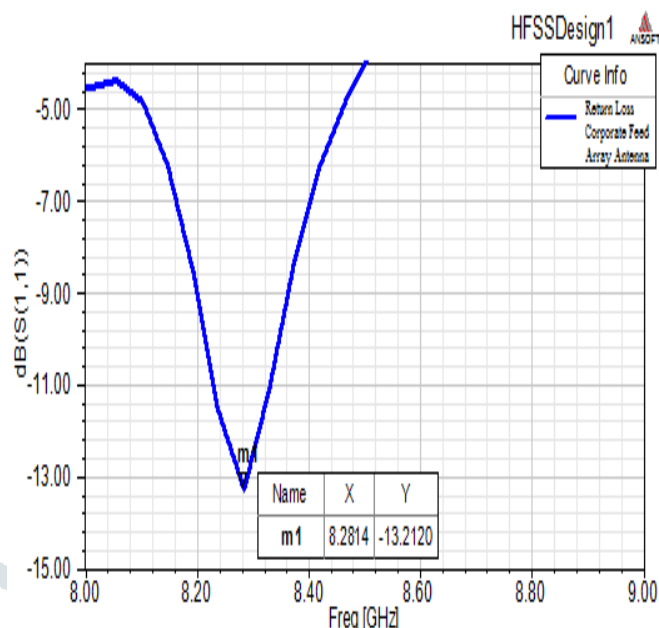


Fig.6: return loss plot of corporate feed array antenna

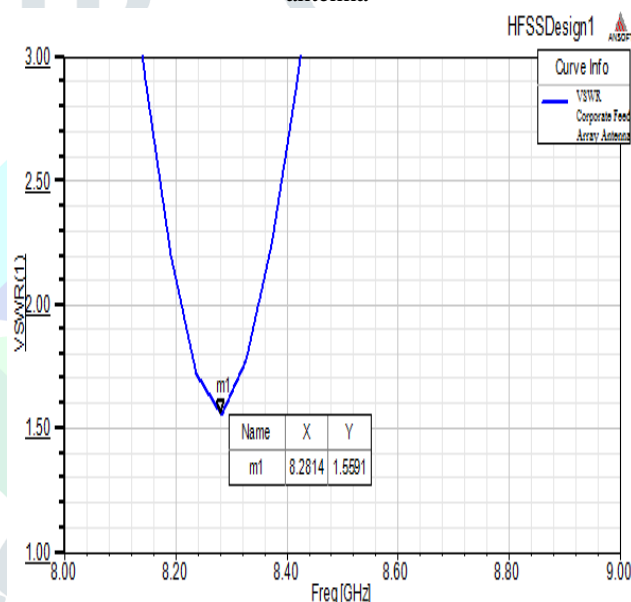


Fig.7: VSWR plot of corporate feed array antenna

Table 2: Parameters to design corporate feed array antenna

Parameter	Value	Parameter	Value
A	50mm	I	4mm
B	22mm	J	2.5mm
C	1mm	K	10mm
D	2mm	L	8mm
E	9.5mm	M	8mm
F	3mm	N	1mm
G	20mm	O	1mm
H	2.5mm	P	1mm

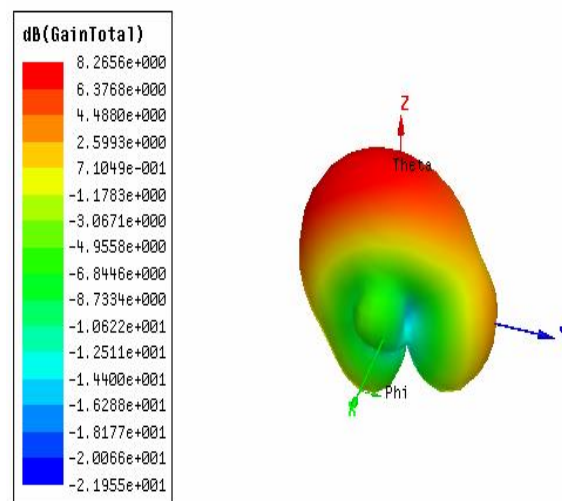


Fig.8: gain plot of corporate feed array antenna

C. CORPORATE-SERIES FEED ARRAY ANTENNA

It is a combination of both series and corporate feeding techniques. Initially the elements are connected using corporate feed technique i.e., by using 1:n power divider network. Then the elements are connected serially. The design of Corporate-Series Feed Array Antenna is shown in figure 11.

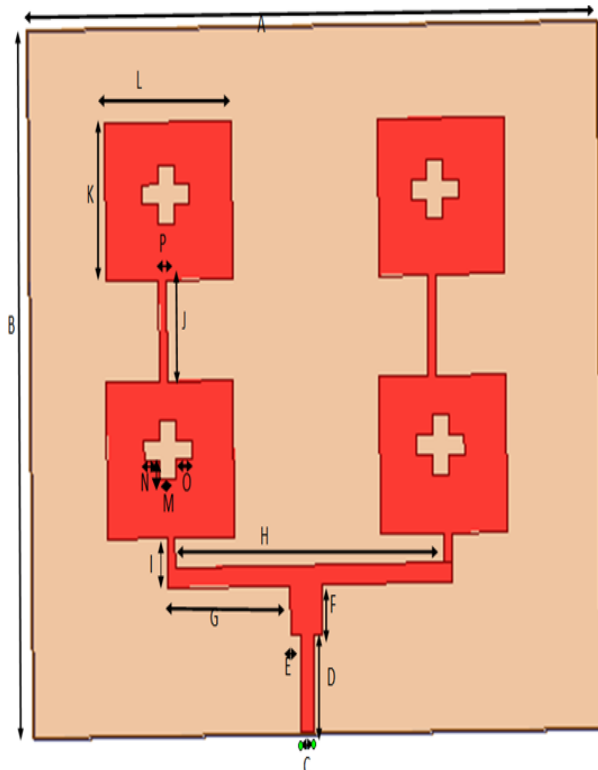


Fig.9: 4 element corporate-series feed antenna with +slot

Return loss plot of Corporate-Series feed array antenna is shown in figure 10. It is resonating at a frequency of 8.32GHz with a return loss of -20.6dB. VSWR plot of Corporate-Series feed array antenna is shown in figure 11. At resonating frequency 8.32GHz, VSWR value is 1.2.

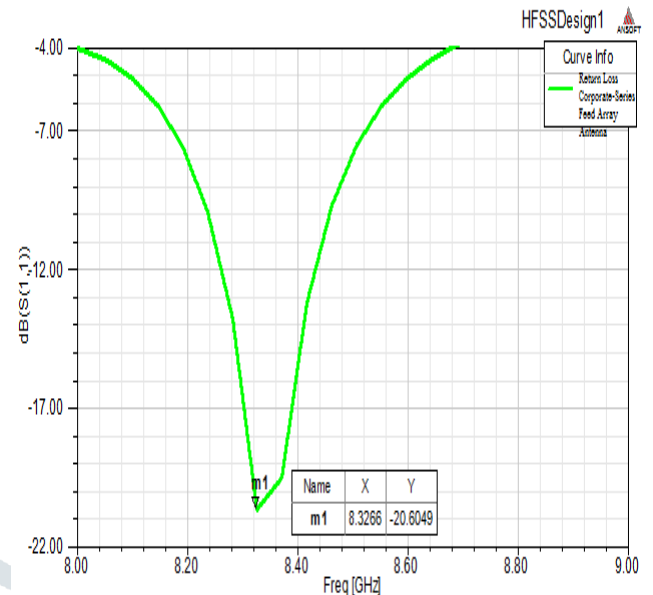


Fig.10: return loss plot of corporate-series feed array antenna

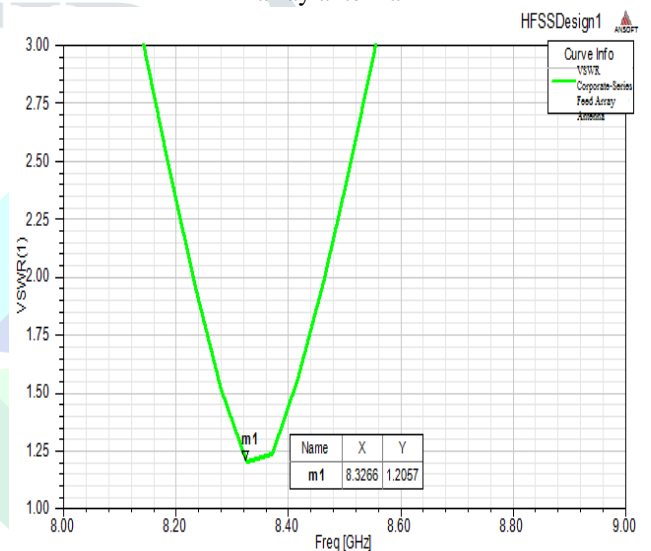


Fig.11: VSWR plot of corporate-series feed array antenna

Table 3: Parameters to design corporate-series feed array antenna

Parameter	Value	Parameter	Value
A	36mm	I	2.505mm
B	36mm	J	5.14mm
C	0.8mm	K	8mm
D	5mm	L	8mm
E	0.6mm	M	1mm
F	2.5mm	N	1mm
G	8mm	O	1mm
H	17mm	P	0.5mm

Gain plot of Corporate-Series feed array antenna is shown in figure 12. The gain for 4 element corporate-series feed array antenna is 12.23dB

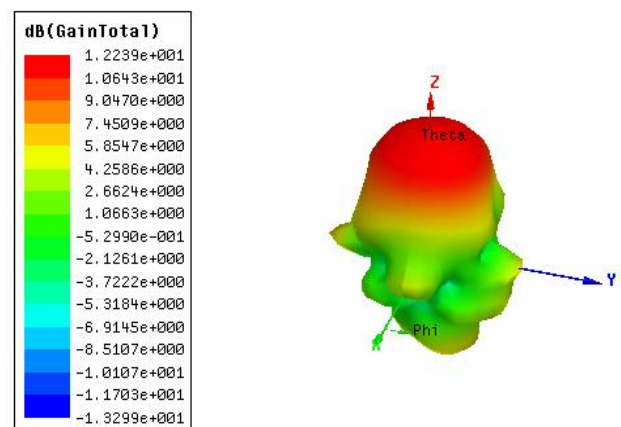


Fig.12: gain plot of corporate-series feed array antenna

Results are summarized in Table 4.

Table 4: Summary of results

Parameters	Series Feed Array Antenna	Corporate Feed Array Antenna	Corporate-Series Feed Array Antenna
Return loss	-14.011dB	-13.16dB	-20.6dB
VSWR	1.49	1.56	1.51
Gain	9.03dB	8.7dB	12.23dB
Impedance	50Ω	50Ω	50Ω

III. CONCLUSION

Array antenna using three different feeding techniques i.e., series corporate and corporate series feed are designed and compared. All the three antennas are applicable for satellite communication. The corporate series feed array antenna has better performance compared to other two feeding techniques. The corporate series feed array antenna is resonating at 8.32GHz with return loss of -20.6dB and VSWR of 1.2 and a gain of 12.2 dB. All the three antennas are suitable for X band applications.

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