Design of Compact Microstrip Patch Array for Wide band Communication

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Abstract

Log periodic arrays are well known for their broad band width with moderate gain. For many applications microstrip antennas well suited because of its inherent properties like lightweight, conformability easy fabrication, but have limitation of low band width and gain. The bandwidth and gain further decreases in compact configuration of the patch. In the present paper compact log periodic microstrip patch has been proposed, which increases the bandwidth and at the same time it also decreases the size of the log periodic microstrip patch array.

Key words: Log periodic arrays, Wide band width microstrip antenna and Compact microstrip array.

1. Introduction

Rectangular and circular microstrip patch elements have got their importance due to low profile, light weight, ease in fabrication and integration. But the most serious limitations are its narrow band width and gain. A number of methods have been proposed in the past such as modified shape, planar multiresonator, multilayer configurations, stacked configuration [1-4] to enhance the bandwidth. Further gain can be improved using the array configuration. Thus log periodic patch array is one of the best forms of the arrays, which helps in improving the gain as well as the band width.

The Log periodic array consists of several elements which are of different length and spacing. The element lengths and relative spacing increases smoothly, as one moves away from the feed point. The subsequent elements are fed at 180^0 out of phase with respect to the previous patch. Same concept is used with the log-periodic patch array. The elements can be the square patch to form the log periodic patch array.

With the proliferation of personal wireless communication, designers search for compact antenna elements for portable devices. The size reduction technique is more beneficial in array application where a large number of elements are to be accommodated in a compact configuration. Several reduced size microstrip patches have been proposed in the past [5-6]. Some of these compact patches also help in increasing the bandwidth. Thus the compact log periodic microstrip patch array is an array which is based on the concept of the log periodic array to improve the band width but uses compact microstrip patches as an element to reduce the size.

2. Antenna Design

First of all the compact element is chosen, which is an inset fed microstrip patch with patch configuration having angular grooves along the edges of the patch. The groove angle is considered as 60^0 as shown in the Fig. 1. The patch area is found to be 39% less than the simple square patch resonating at the same frequency 2.44 GHz. Using this element and following the procedure given in [7], a compact log periodic microstrip patch array, with four elements was formed on a FR4 glass epoxy dielectric substrate with dielectric constant 4.4 and thickness 1.6 mm. The spacing between the patch is maintained at $\lambda_g/2$. The arrays were fabricated in the suspended configuration, with an air gap of 0.16mm. The conventional log periodic patch array [7] and the proposed compact patch array are shown in the Fig.2a and Fig. 2b. The presence of air increases the height hence reduces the effective dielectric constant. This helps in further increasing the bandwidth of the antenna. The dimensions of the log-periodic microstrip patch array, both simple and compact, are shown in the Table 1. The comparison of the two log- periodic microstrip patch array is shown in the Table 2. The dimension of the patch and the inset feed location for the desired frequency of operation is obtained from the GA optimization procedure inbuilt with the IE3D, a full wave Method of Moments (MOM) based simulator from Zeland, USA.

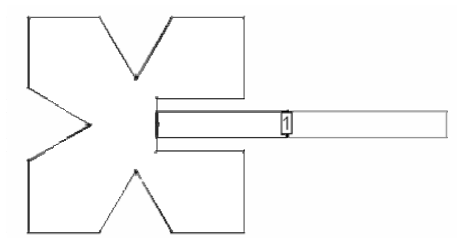

Fig. 1 Compact microstrip patch element

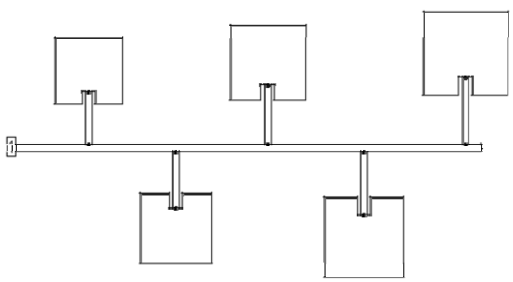

Fig. 2a Log- periodic microstrip patch array using five square patch elements

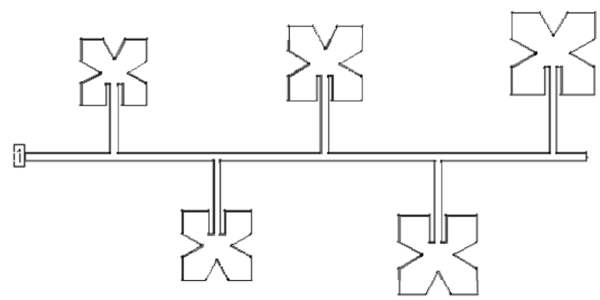

Fig. 2b Compact log- periodic microstrip patch array using five compact patch elements

Table 1 Dimensions of the Elements of Air Suspended Inset Fed Simple and Compact Log-periodic Array

f_r (GHz)	Dimensions of Simple Square Patch			Dimensions of Compact Patch		
	L = W (mm)	Inset Depth (mm)	Inset Length (mm)	W (mm)	Inset Depth (mm)	Inset Length (mm)
2.68	37.998	8.3	30.27	31.473	10.7	32.67
2.82	35.918	7.7	28.58	29.782	10	30.88
2.97	33.879	7.2	27.02	28.126	9.4	29.22
3.13	31.924	6.6	25.41	26.586	8.7	27.51
3.29	30.169	6.1	24.00	25.148	8.2	26.1

3. Results And Conclusion

The prototype model developed is fabricated and tested for the return loss characteristics. As shown in Fig. 3 the fabricated antenna shows a wide bandwidth characteristic in the frequency range from 2.75 GHz to 3.3GHz and 5.1GHz to 10.8 GHz. The radiation patterns in both E-Plane and H-plane are determined at various frequencies such as 3 GHz, 3.3GHz, 5.7 GHz, 7GHzand 9 GHz. However, the pattern characteristics are reported at frequencies 3.3 GHz and 5.7 GHz are shown in Fig. 4 and Fig. 5. As evident from Table 2, the bandwidth of the antenna in the proposed configuration increases more than eleven times the bandwidth as compared to the conventional [7] configuration.

The proposed antenna is found to be a good candidate for the wide band application especially where compact configuration is desirable due to space constraint.

Table 2 Comparison of Bandwidth of Air Suspended Square and Air Suspended Compact Log-periodic Array

Types of Antenna	Band width (in MHz)
Air Suspended Square inset fed LPDA	535
Air Suspended Compact inset fed LPDA	6170

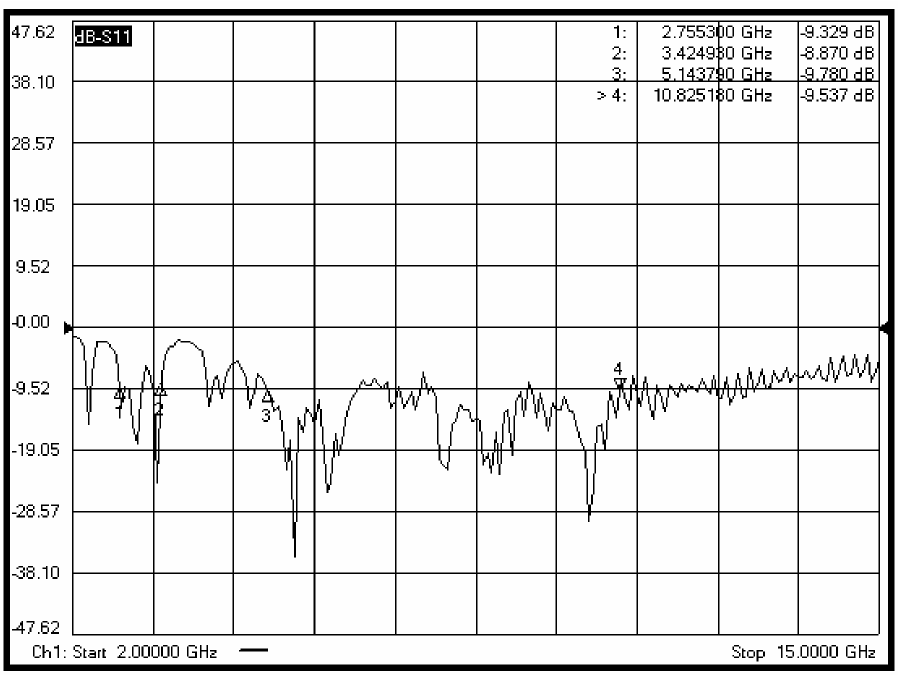

Fig. 3 Return Loss Characteristic of Compact Log Periodic Patch Array

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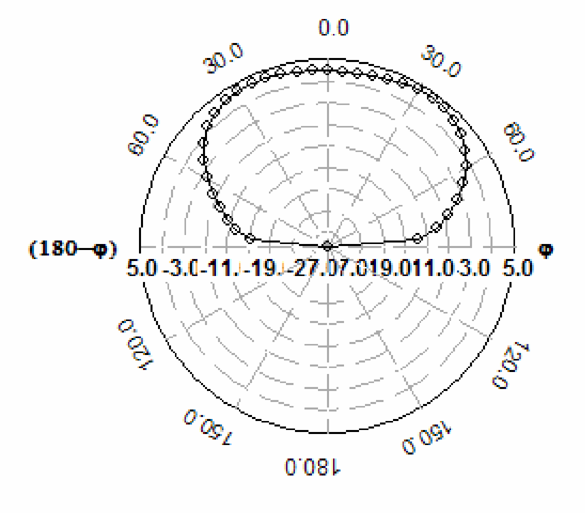

Fig. 4a E- Plane Pattern at 3.3 GHz

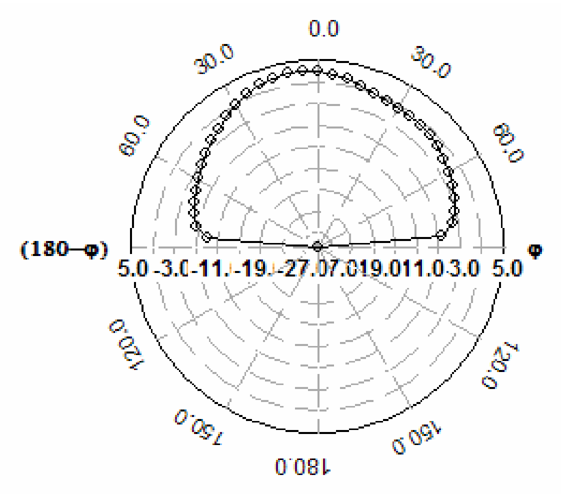

Fig. 4b H- Plane Pattern at 3.3 GHz

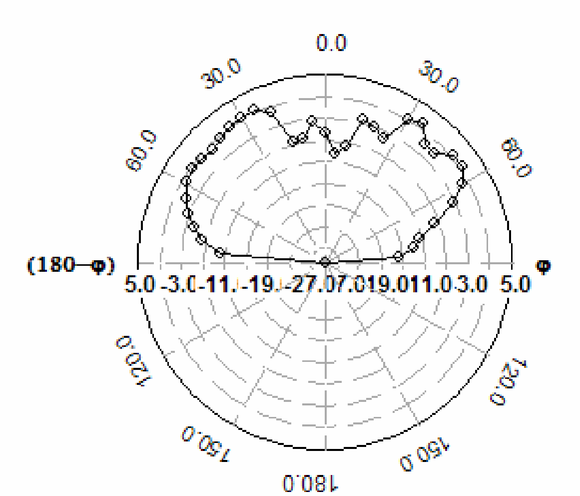

Fig. 5a E- Plane Pattern at 5.7 GHz

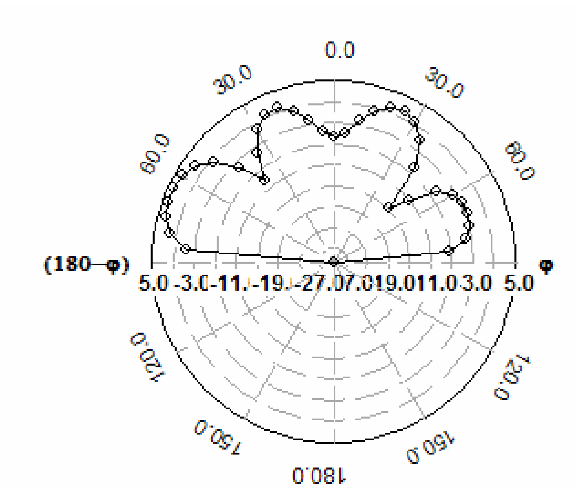

Fig. 5b H- Plane Pattern at 5.7 GHz

5. References

1. K. L. Wong, W. H. Hsu, "Broadband Triangular Microstrip antenna with U-Shaped slot," *Electronics Letters*, Vol. 33, No. 25, 1997, pp. 2085-2087.
2. K. Anandan and K. G. Nair, " Compact Broadband Microstrip antennas," *Electronics Letters*, Vol. 22, No. 20, 1986, pp. 1064-1065.
3. R. Q. Lee, K. F. Lee and J. Bobinchak, "Characteristics of a Two-Layer Electromagnetically Coupled Rectangular Patch antenna," *Electronics letters*, Vol. 23, No. 20 1987, pp. 1070-1072.
4. B. Balakrishnan and G. Kumar, "Wide band and High gain Electromagnetically Coupled Circular Microstrip Antennas," *IEEE AP-S Int. Symp. Digest*, June 998, PP. 1112-1115.
5. V.R. Gupta & N. Gupta, "Characteristics of a Compact Microstrip Antenna", *Microwave and Optical Technology Letters*, Vol. 40, No. 2, Jan. 2004, pp 158-180
6. N. Gupta and V. R. Gupta, "Microstrip Patch antenna for 2.4 GHz. Band," *Proc. of Asia-Pacific Microwave Conference (APMC-2004), New Delhi,* December 15-18, 2004.
7. R. Kakkar and G. Kumar, "Staggered Tuned Microstrip Log-Periodic Antenna," *IEEE AP-S Int. Symp. Digest*, June 1996, pp. 1262-1265.