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A Literature Review on Wideband Microstrip Patch Antennas Using Multiple Stacked Elements

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Abstract— *Several designs have been proposed in the literature to improve the bandwidth of microstrip patch antenna which includes the use of thicker substrates, different shape patches and probes, addition of parasitic patches and cutting of slots. In this paper we are presenting various useful bandwidth enhancing stacked configurations of microstrip patch antennas which are able to provide broader bandwidths with enhanced gain.*

***Keywords*— Bandwidth, Gain, Stacked, Patch Antenna.**

1. INTRODUCTION

Microstrip patch antennas are currently widely used particularly since they are low profile lightweight, compact and cost effective; however, their main disadvantage is their narrow bandwidth and low gain in practical applications. For present-day wireless communication systems, the required operating bandwidths for antennas are about 7.6% for a global system for mobile communication (GSM; 890–960 MHz), 9.5% for a digital communication system (DCS; 1710–1880 MHz), 7.5% for a personal communication system (PCS; 1850–1990 MHz), and 12.2% for a universal mobile telecommunication system (UMTS; 1920–2170 MHz)[1].

Various designs have been proposed in the literature to improve the bandwidth of microstrip patch antenna which includes the use of thicker substrates, different shape patches and probes, addition of parasitic patches [1]–[4] and cutting of slots [5]–[8]. In our case we are presenting various useful bandwidth enhancing stacked configuration of patch antennas which are able to provides broad bandwidth of nearly 19%, 21%, 59.7% [9]-[13].

2. LITERATURE REVIEW

2.1 Bandwidth Enhancement of Stacked Rectangular Microstrip Patch Antenna[10]

In this paper rectangular microstrip patch antenna was investigated and its performance was analyzed in Microwave Office Package 2000. An additional rectangular conductive plate of comparable dimensions was placed above the patch in order to enhance the bandwidth by using the resonant principle of patch antenna given in[1]. The effect of the top patch, in particular the variation of VSWR with two parameters, namely the distance between the two patches and the size of the upper patch was analyzed. A bandwidth of 11 for VSWR<2 has been achieved for stacked rectangular patch designed to operate in the S-band when a dielectric of thickness one centimeter and relative permittivity of 2.6 has been taken into consideration.

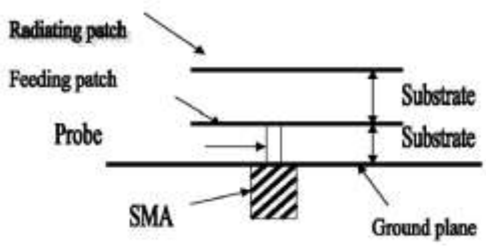
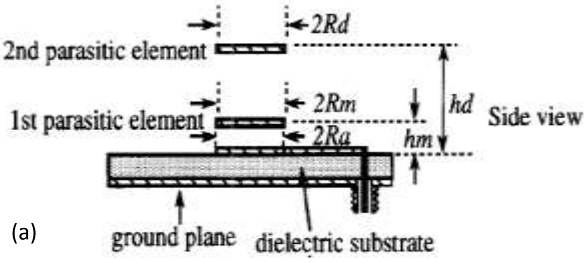


Fig. 1 The configuration of the stacked microstrip patch antenna.

2.2 Stacked Microstrip Antenna with Wide Bandwidth and High Gain[11]

A stacked microstrip antenna with two additional parasitic patches one of which enhances the gain and the other one of which increases the impedance bandwidth, has been investigated experimentally. The effects of each parasitic element have been clarified as well as the characteristics of the stacked three-element antenna and the design procedure for the stacked microstrip antenna have been described. For various *Rd/Ra,* a maximum axial ratio bandwidth and a maximum directivity were obtained at *Rd/Ra*=1.0. The corresponding maximum axial ratio bandwidth and maximum directivity of 11.7 dBi was obtained at *hd*=0.50 . At the maximum gain of 10.6 dBi, the impedance and the axial ratio bandwidths were 10% and 8.5%, respectively. The 3-dB beamwidth of the radiation pattern was 40 degree for a stacked three-element antenna and 52 degree for a single-patch antenna as a reference.

(a)



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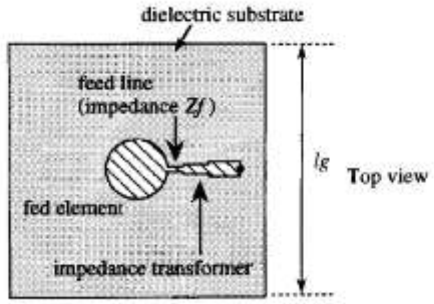
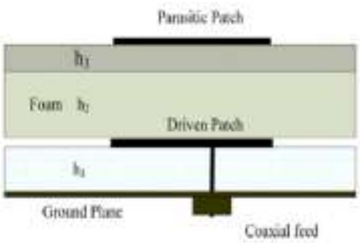


Fig. 2 Structure of stacked microstrip antenna with linear polarization. (a) Side view (b) Top view.

2.3 Wideband Circularly Polarized Stacked Microstrip Antennas[12]

In this paper a simple technique is developed to improve the axial ratio (AR)-bandwidth and quality of circularly polarized stacked microstrip antennas using a new C-type single feed. The antenna has 10 dB return loss bandwidth of 21%, 3 dB AR bandwidth of 13.5% and gain is more than 7.5 dBi over the 3 dB AR bandwidth. The design process is simple because the axial ratio and return loss requirements are achieved at different stages almost independently. The return loss, axial ratio, gain and radiation patterns of the antenna have been measured and presented. Further optimization of the aspect ratio of the driven patch and the substrate thickness can provide even wider AR bandwidth. The proposed feed optimization technique is useful for rapid design of circular polarized stacked microstrip antennas.

(a)



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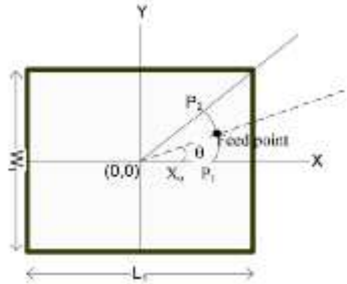
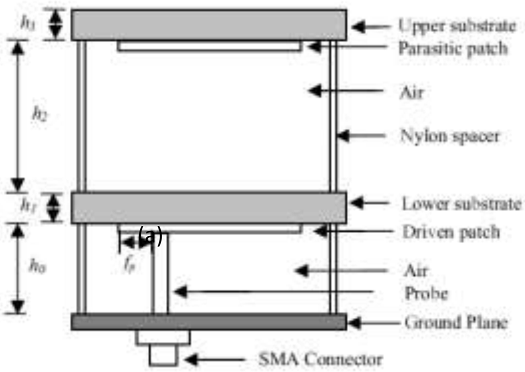


Fig. 3 (a) Circularly polarized stacked patch antenna with C-type feed (b) Driven patch.

2.4 Stacked Multiple Slot Microstrip Patch Antenna for Wireless Communication System[13]

In this paper stacked probe fed inverted multiple slot microstrip patch antenna is designed. The composite effect of stacked patch antenna and introducing the multiple shaped patch, offer a low profile, high gain, and compact antenna element. Simulated results for main parameters such as return loss, impedance bandwidth, radiation patterns and gains are also discussed here. The study showed maximum achievable gain of about 11.44 dBi with simplicity in feeding and designing, can well meet for base station wireless communication system application. The resonant properties of the proposed antenna have been predicted and optimized using a frequency domain three-dimensional full wave electromagnetic field solver (Ansoft HFSS). The two closely excited resonant frequencies at 1.85 GHz and at 2.1 GHz as shown in the figure gives the measure of the wideband characteristic of the patch antenna. The simulated VSWR≤2 bandwidth is 19.8% from 1.82 GHz to 2.22 GHz is achieved at 10 dB return loss.

(a)



(b)

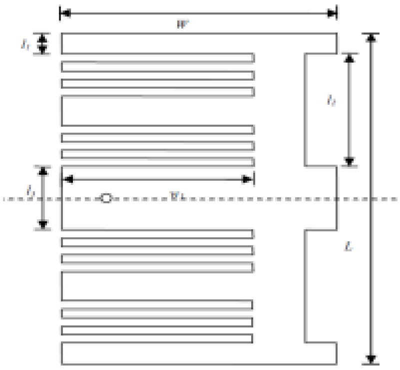
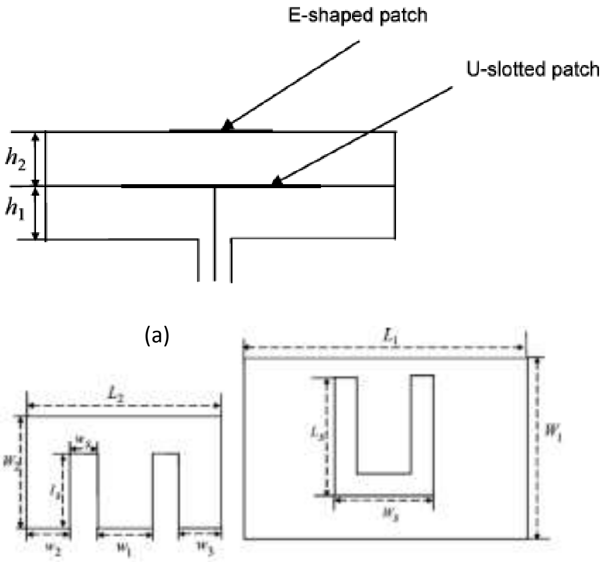


Fig. 4 The geometry of the proposed multiple slotted patch antenna. (a) Side view (b) Top view.

2.5 Probe Fed Stacked Patch Antenna for Wideband Applications [14]

This article shows a new design of a U-slot microstrip antenna with an E shaped stacked parasitic patch is that achieves an impedance bandwidth of 59.7%. Parameters such as slot length, width and substrate thickness was investigated and design results from parametric simulations were presented. The return loss of the proposed design is 10 dB across the band frequency 3.28–6.07 GHz which shows 5.7% increase in bandwidth in comparison to the patch antenna with two E-shaped stacked parasitic patches. The radiation patterns are relatively constant throughout the whole bandwidth.



(b)

Fig. 5 Antenna structure. (a) side view (b) E and H-shaped patch.

3. CONCLUSION

This paper presents brief review of all the techniques discussed above that enhance wideband characteristics; and hence provides a succinct material for beginners in the field of high gain wideband patch antenna design. By utilizing these structures we can fabricate patch antennas for various applications such as radar, cell phone and satellites to achieve high gain, high data rate and speedy communication.

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